STRATEGICALLY THINKING ABOUT STRATEGIC PLANNING IN RESEARCH: THE PATH TO CORRELATING INSTITUTIONAL SUPPORT WITH RESEARCH OUTCOMES

by

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Abstract

Academic research universities face a constant challenge to sustain their operations and provide the resources and support necessary for their faculty and researchers to promote the advancement of science and technology. To accomplish this, most universities engage in the crafting of strategic plans that incorporate standard measures for increasing research productivity and outcomes. The aim of this project was to investigate the institutional variables that influence research outcomes and determine if a significant correlation exists between institutional financial and personnel support, and research outcomes as measured primarily through funding, publishing and citations. A sample of thirteen strategic plans from research universities across the United States were selected and grouped by their Carnegie Classifications, with five classified as public High Research Activity, five as public Very High Research Activity, and three as private Very High Research Activity universities. Each of the strategic plans was first analyzed using a method of content analysis, which identified three categories, each containing multiple subcategories, that were used to determine the areas of primary focus for university research. Results from the content analysis provided the selection of variables related to institutional infrastructure, input, output, and impact factors, for which data was collected primarily using publicly available open access systems.

Two methods of statistical analysis were used to identify the presence of statistically significant correlations between the variables related to infrastructure and research outcomes. Data analysis using the Pearson Correlation method identified 560 correlations, 241 of which were further determined to be statistically significant using linear regression analysis.

Universities with higher rates of research outcomes over the course of their strategic plans also had higher numbers of significantly correlated variables. The results of the project

supported the hypothesis that increased attention, investment, and planning at the institutional level, leads to increased research productivity and outcomes, and provide valuable insight into the specific variables that influence university research in relation to the unique characteristics of the university.

Primary Reader – Jeffrey Kantor, PhD

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Abbreviations

CU	Cornell University
FTE	Full Time Employees
HERD	Higher Education Research and Development
HRA	High Research Activity
IHE	Institute of Higher Education
IPEDS	Integrated Postsecondary Education Data System
JHU	Johns Hopkins University
KU	University of Kansas
NCES	National Center for Education Statistics
NHF	New Hire Faculty
NIH	National Institutes of Health
NSF	National Science Foundation
NWU	Northwestern University
OSU	Ohio State University
PPE	Plant, Property and Equipment
R&D	Research and Development
RePORT	Research Portfolio Online Reporting Tools
TCE	Total Core Expenses
TSU	Texas State University
TTU	Texas Tech University
UAF	University of Alaska, Fairbanks

UH	University of Hawaii
UK	University of Kentucky
UMB	University of Massachusetts, Boston
UME	University of Maine
USPTO	United States Patent and Trademark Office
VHRA	Very High Research Activity
WSU	Washington State University

Chapter 1: Introduction

Like a hybrid goliath, the research enterprise balances precariously between the dueling identities of a global business conglomerate and an academic institution for public service and advancement. While its presenting image is always that of the latter, it is the former that is often witnessed by those working from within. The challenges faced from such a dichotomy are unique to the academic research enterprise, where business operations serve the necessary evils that sustain and promote the advancement of science and research. The competitive environment that increasingly enshrines research universities and institutions, places pressure on leadership to sustain and promote academic and scholarly freedom, while fiscally managing the business operations that support them. Lacking a traditionally tangible product to sell, research universities often struggle to provide the resources and support that researchers need to pursue their projects and increase their contribution and impact to the field, as well as their ability to compete for research funding. The debate emerges over how much responsibility the faculty researcher should take for their own survival and production, versus the level of support the institution is capable and willing to provide.

To bridge the business and academic gap, strategic plans are often created and implemented by universities as a means of outlining their desired goals and direction. The research university strategic plan has served as a guide to promote the production of research outcomes developed by their faculty, which in-turn would lead to increased funding from competitive sponsors. However, the complexities of the research enterprise, make it challenging to uncover the specific forces that work to promote and influence the advancement of research productivity and outcomes.

By exploring the structures of research university strategic plans, this project aims to seek out the specific nature of the many variables related to institutional infrastructure and support that influence the research activity produced by the university's faculty and research enterprise. The heart of the project is to discover a means to investigate the relationship between the research institution's financial and personnel support structures and the research outcomes that are produced and received. Having this knowledge would aid universities in their strategic planning efforts by advancing the level of organizational intelligence that it has on the internal variables that may be operating to strengthen or weaken their enterprises, along with the ability to peer deeper into the larger community of research universities that surround it. Strategically thinking about strategic planning in research, holds the key to developing a more effective correlation between the research university's dueling identities.

Chapter 2: Literature Review

The academic research enterprise, as practiced through Institutes of Higher Education (IHE), is an environment quite distinct from the corporate business model, and yet for the last several decades it has implemented one of the corporate world's most ubiquitous tools. Strategic planning has permeated academia in the ever-evolving trend to navigate with business savvy vision, the dynamically changing university landscape. Universities are increasingly engaged in a multi-faceted competition for the physical, financial, and human resources vital to their growth and survival. Research universities are especially vulnerable to these competitive influences, given the high cost of operating modern research facilities and the need to attract and retain the intellectual capital that serves as the engine of research performance. Universities engaged in research activity have incorporated their research components into their strategic planning processes, and in many cases develop dedicated strategic plans for research, which provide insight into internal and external influences that impact the research enterprise. To interpret and explore the strategic plans used by research universities, an understanding of their unique nature compared to their corporate counterpart, and how they have been examined in previous studies and reviews, is a vital first step to investigating their effect on research activities and outcomes.

2.1: Emergence of Strategic Planning in Academia

From its roots in the business and corporate sector, strategic planning at its base core function can be defined as

> "…an organizational management activity that is used to set priorities, focus energy and resources, strengthen operations, ensure that employees and other stakeholders are working toward common goals, establish agreement around intended outcomes/results, and assess and adjust the organization's direction in response to a changing environment. It is a disciplined effort that produces fundamental decisions and actions that shape and

guide what an organization is, who it serves, what it does, and why it does it, with a focus on the future."[1]

While this serves as a very good and straight forward working definition of strategic planning, its square adoption into the circular academic world of higher education and research has often been viewed as a forced struggle. Academia's interest in the strategic plan began in the late 1950s and early 1960s in response to the need for planners to manage the expansion of university facilities during a time marked by financial growth and support.[2] However, as illustrated by Michael Dooris, John Kelley and James Trainer, by the 1970s and 1980s, "[h]igher education costs began to consistently outpace inflation, and foundational stress fractures were detected in the public's support for higher education. Ideas about planning began to change."[3] Capturing the turbulent moment, George Keller's 1983 work, *Academic Strategy: The Management Revolution in American Higher Education*,[4] moved the concept of strategic planning into the academic sphere, becoming what Paul Temple describes as "one of the first works to suggest strategic approaches to the management of higher education institutions."[5] Keller's influential work combined with the unstable outlook for higher education, led to the expanded influence of strategic planning within the university structure.

Distinct from their reversed mirror corporate image, academic research universities exist within a unique culture unshackled from the emphasis on quantitative profits. Trading in a

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[1] Balanced Scorecard Institute. (2017). Strategic Planning Basics. [webpage], accessed Spring 2019, https://www.balancedscorecard.org/BSC-Basics/Strategic-Planning-Basics

[2] Dooris, M. J., Kelley, J. M., & Trainer, J. F. (2004). Strategic planning in higher education. *New Directions for Institutional Research*, *2004*(123), 5–11, accessed Spring 2019, https://doi-org.proxy1.library.jhu.edu/10.1002/ir.115

[3] Dooris, Kelley & Trainer, *Strategic planning in higher education,* 7.

[4] Keller, G., Cyert, R. M. (1983). *Academic Strategy: The Management Revolution in American Higher Education*. United Kingdom: Johns Hopkins University Press.

[5] Temple, P. (2018). "Academic Strategy: The Management Revolution in American Higher Education," by George Keller (1983) Can Strategy Work in Higher Education? *Higher Education Quarterly*, *72*(2), 170–177, accessed Spring 2019, http://search.ebscohost.com.proxy1.library.jhu.edu/login.aspx?direct=true&db=eric&AN=EJ1174513&site=ehost-live&scope=site

collective commerce of intellectual discovery and advancement, university structures were forced to modify the way strategic planning was defined to create a more compatible union. The academic research university is an ecosystem of competing multidisciplinary cultures, each with its own distinctive culture and established system of accepted norms. In her work, *A Practical Guide to Strategic Planning in Higher Education*, Karen Hinton describes "the competing and sometimes opposing operational cultures of the academy [that] captures the essence of an organization which, at its core, finds institutionally comprehensive planning antithetical to many of the activities that give American higher education its unique, dynamic character."[6] Acknowledging the challenges that strategic planning faces when confronting the unique identity of the academic research university is well discussed throughout the literature. Kathleen Immordino, Ralph Gigliotti, Brent Ruben, and Sherrie Tromp, document that "[w]ith its range of missions, multiplicity of stakeholders and distinctive shared governance structures, higher education is a unique industry requiring special considerations when it comes to strategic planning."[7] Delving further into the university application of strategic planning, Dooris, Kelley, and Trainer, express that:

> "Since most institutions of higher education share a similar mission and compete for these same objectives, an essential part of strategic planning involves shaping the institution in ways that ensure mission attainment by capturing and maintaining a market niche in the quest for resources, faculty, and students. Thus, strategic planning has both external and internal faces."[8]

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[6] Hinton, K. (2012). *A Practical Guide to Strategic Planning in Higher Education*. Society for College and University Planning. 7, accessed Spring 2019, https://oira.cortland.edu/webpage/planningandassessmentresources/planningresources/SCPGuideonPlanning.pdf

[7] Immordino, K. M., Gigliotti, R. A., Ruben, B. D., & Tromp, S. (2016). Evaluating the Impact of Strategic Planning in Higher Education. *Educational Planning, 23*(1). 35-47. 35, accessed Spring 2019, http://isep.info/wp-content/uploads/2016/04/23-1_4evaluatingimpact.pdf

[8] Ibid., 6.

In the efforts to adhere the concept of strategic planning to the academic research university, Alton Taylor and Scott Karr, succinctly relate that "[s]trategic planning is a matching process between an institution and its environment predicated on a realistic evaluation of both."[9]

2.2: The Rise of Strategic Thinking

The entrance of strategic planning into the university environment was not unanimously welcomed. It was perhaps inevitable that an institutionally designed planning process, born out of the singularly focused and hierarchical business universe, would clash with the academic structures built by conceptually trained rouges and on an ideology of critical challenge. In 1994, Henry Mintzberg, a professor of management at McGill University, protested the rise of strategic planning by espousing its downfall while elevating the alternative concept of strategic thinking. Mintzberg argued that "strategy making is an immensely complex process, which involves the most sophisticated, subtle, and, at times, subconscious elements of human thinking."[10] Relating the strategic planning process to the complexities of human thought, and by extension social behavior and interaction, represented a critical point in the relationship between strategic planning and the academic research university, and its importance is central to the process of analyzing the value of current strategic initiatives. In his work, Mintzberg concluded that:

> "While certainly not dead, strategic planning has long since fallen from its pedestal. But even now, few people fully understand the reason: *strategic planning* is not *strategic thinking*. Indeed, strategic planning often spoils strategic thinking, causing managers to confuse real vison with the manipulation of numbers…When companies understand the difference between planning and strategic thinking, they can get back to what the strategy

[9] Taylor, A. L., & Karr, S. (1999). Strategic Planning Approaches Used to Respond to Issues Confronting Research Universities. *Innovative Higher Education*, *23*(3), 221–234, accessed Spring 2019, https://doi-org.proxy1.library.jhu.edu/10.1023/A:1022998518559

[10] Mintzberg, H. (1994). The Fall and Rise of Strategic Planning. *Harvard Business Review, January-February*. 107-114, accessed Spring 2019, https://hbr.org/1994/01/the-fall-and-rise-of-strategic-planning

> process should be: capturing what the manager learns from all sources… and then synthesizing that learning into a vision of the direction that the business should pursue."[11]

The impact of strategic thinking on the creation and implementation of strategic plans in the research university setting cannot be underestimated, as the contrast between planning and thinking is a central element in their analysis.

The concept of strategic thinking permeates the current literature in both direct and indirect ways. The former being illustrated in Taylor and Karr's observation that, while we have yet to mourn strategic planning's death, "[s]trategic thinking, in the university context, may be considered a component of strategic planning, rather than a radically new planning concept [and that] Mintzberg's critique may be more semantic than substantive."[12] Taylor and Karr's intentional blending of the two recognized the reality that the two concepts were not necessarily opposed but rather could be formed into the development of a more comprehensive approach uniquely suited to the cultural environment of the research university.

2.3: Important Strategic Plan Components Related to University Research

The basic formula and structure of the strategic plan and the planning process is well documented throughout the business, management, and administrative fields, and while the focus of this paper is on utilizing strategic plans as mechanisms for the analysis of university research structures and productivity, it is important to understand the key components that will be examined.

Goals vs. Objectives

The vast majority of strategic plans are constructed around the organization's use of goals and objectives. Their establishment clearly illustrates the direction, focus, and priorities of the

[11] Mintzberg, H. *The Fall and Rise of Strategic Planning*, 107.
[12] Taylor, A. L., & Karr, S. *Strategic Planning Approaches*, 226.

organization, along with a reflection of its aspirations and current stature. While the two appear similar and are often used in the same manner, their differences warrant further understanding. Hinton indicates that:

> "The word goal connotes specific achievement; a target reached and "checked off". The word objective is slightly more general in connotation. An objective helps set a course by giving a general direction, but an objective does not usually contain the specifics of its own completion. Given the nature of the activities required to implement a plan, and the need to assess the achievement of the plan's implementation, it seems logical to use terms that encourage overarching directional guidance for the major themes that organize the plan, and more specific terms for the parts of the plan requiring accountability and measurement."[13]

While it may seem trivial to define terms so closely connected, the justification becomes clear when one examines the way in which they are used by research universities to express their desired prospects and endeavors. For a research university, as an organization built around conceptual scrutiny, clearly demarcating the yellow brick road to their ambitions can be a critical component to ensuring the greatest opportunity of success.

Administration

Strategic Plans in research universities surprisingly often paint more than just a picture of their desired direction and future growth. In many examples, their plans provide a glimpse into the internal dynamics of the institutional and research administration environment in which they may either wish to develop or outright change. Here again, Hinton discusses that "there are a number of issues that bear on assessment within the context of "administration". Personnel evaluation systems aside, assessing staff retention, satisfaction, and training and development

[13] Hinton, K. *A Practical Guide to Strategic Planning*, 11.

programs would seem to be an obvious area of import for any institution."[14] Elements such as these often serve as indicators to the health and culture of the institutional and research administration infrastructure which can have a direct impact on a university's research productivity. Hinton further expresses that "these same issues have a direct impact on resource allocation and should be included in the strategic plan so they can be prioritized and budgeted."[15] Administrative considerations are a central focus in the exploratory analysis of this paper, and while budget and resource allocation factors can be an expected component in many strategic plans, issues related to those discussed by Hinton, including staff retention, satisfaction and development, provide valuable insights for understanding the more complex influences that administration exerts on organizational dynamics.

Positive and Negative Factors in Strategic Planning

When considering the positive and negative forces at play in the research university strategic planning process, it is important to remember that unlike the corporate structure, academic and research universities exist as unique and individual islands distinct from one another. The result, as Susan Resneck Pierce explains, is that "[t]here is no magic bullet or single approach that fits all institutions. What works at one institution many not work even for competitors that have similar if not identical missions."[16] However, the literature does point to several elements that have both positive and negative effects that are common across the research university landscape.

[14] Ibid., 19.
[15] Ibid., 19.
[16] Pierce, S. R. (January 31, 2017). Hope and Denial are Not Strategies: How colleges should rethink their strategic planning processes. *Inside Higher Ed*, accessed Spring 2019, https://www.insidehighered.com/views/2017/01/31/how-colleges-should-rethink-their-strategic-planning-processes-essay

Positive Factors. Perhaps one of the most imperative factors to creating a positive strategic plan is in the fundamental understanding that the entire process is an exercise in open communication. In their study on the communicative nature of strategic planning, A. Paul Spee and Paula Jarzabkowski expressed that after:

> "[d]rawing upon the organizational communication literature, we re-conceptualize strategic planning as being constituted through a communicative process. This view goes beyond the commonly held perspective within the strategic management field, which considers communication as occurring after a plan is developed to regarding the plan as an emerging text that shapes and is shaped by the communication process."[17]

Rather than a hierarchal dissemination of a plan designed to manifest a particular response, strategic planning achieves the greatest benefit by acting as a mechanism through which a diverse range of stakeholders can openly develop a common path based on shared concerns and a mutual motivation to achieve success.

Fostering an open and communicative process provides the foundation for another factor in positive planning. A common point expressed throughout the literature related to strategic planning in research universities, is the necessity to be grounded in the environmental reality that the organization operates within. In her work with universities during their strategic planning, Pierce noted that successful models were found in institutions where "[p]lanning was simultaneously aspirational and feasible, ultimately mediating between the real and the ideal."[18] The need to maintain a grounded vison was further illustrated by Victoria Molfese, et. al., who included the additional aspect of the positive contribution made by the research administrator in their conclusion that:

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[17] Spee, A. P., & Jarzabkowski, P. (2011). Strategic planning as communicative process. *Organization Studies*, *32*(9), 1217–1245, accessed Spring 2019, https://doi-org.proxy1.library.jhu.edu/10.1177/0170840611411387

[18] Pierce, S. R. *Hope and Denial are Not Strategies*.

> "To achieve strategic goals successfully, organizations must realistically assess their areas of research strengths and weaknesses, carefully evaluate opportunities for attaining strategic objectives, and set reachable yet ambitious action plans. Research administrators' and managers' roles in identifying the benefits that organizations can derive from research, opportunities for growth of research activities, and funding sources for research are essential to the strategic planning process."[19]

The involvement of the research administrator in the strategic planning process, illustrates how the participation of key stakeholders from all levels and operational areas works to contribute in positive collaboration for the goal of developing an achievably successful strategic plan.

Negative Factors. In direct contrast to the need to develop plans grounded in reality, lies the failure of crafting a plan based upon unattainable dreams of grandeur. Drawing on her experience in the field, Pierce again highlights that "Sadly, many planning processes fail because those involved have been encouraged to "Blue Sky It" without grounding their planning in a clearly-articulated vision for the future," further elaborating that "it is a recipe for disaster when those involved in planning are asked to imagine a rosy future without regard to available resources: human, financial and facilities."[20] Unfortunately, the need to emphasize the point of remaining grounded and out of the clouds when crafting a strategic plan, is one which must be expressed in both its positive and negative forms given the pervasiveness of the issue throughout the university organizational ecosystem.

Another factor frequently cited in the literature as having a negative impact on the success of strategic planning in the university setting, is the inherently ridged nature of strategic

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[19] Molfese, V., PhD., Chronister, L., M.P.A., Kulakowski, E. C., PhD., Slocum, J. M., Studman, C., PhD., & Waugaman, P., M.P.A. (2008). Voice of experience: The strategic planning process: Applications to research universities and predominantly undergraduate institutions. *Journal of Research Administration, 39*(1), 85-92,6-8, accessed Spring 2019, https://search-proquest-com.proxy1.library.jhu.edu/docview/216585976?accountid=11752

[20] Ibid.

planning that Mintzberg so forcefully railed against. Illustrating the uniquely dynamic organizational and ideological structures that form the academic and research enterprises, demonstrates the need for strategic plans in these fields and organizations to be flexible and agile in their ability to respond to changing internal and external conditions. Respondents to Taylor and Karr's study, *Strategic Planning Approaches Used to Respond to Issues Confronting Research Universities*, expressed that:

> "Inflexibility and rigidity created by the plan was the greatest concern. Interviewees cited as specific problems: creating an overly detailed and comprehensive plan; not recognizing that most advances come from seizing an opportunity and that events quickly overtake plans; focusing too much on money and budgets; and being overly bureaucratic in implementing the plan."[21]

Effectively nimble strategic plans require a structure designed to be adaptable to change and open to continuous review. Hinton observed that "[t]he key to keeping a strategic plan flexible and continuously updated is a regular schedule of assessment and revision"[22] which leads to a sustainable plan that can efficiently adjust to the changing needs of the institution and its participants and stakeholders regardless of the environmental fluctuations that it may encounter.

Correlating Strategic Plans with Institutional Budgets

The goals, objectives and initiatives charted by strategic plans for research universities are not designed to be mere abstractions of thought, but rather are concreate investments that are rarely cheap in either financial or human capital. As Hinton quite simply states, "[o]f all the processes that benefit from a strategic plan, long-range budgeting has the most direct relationship."[23] Navigating the road to achieving any strategic plan milestone will come at an

[21] Ibid., 230.
[22] Ibid., 20.
[23] Ibid., 35.

institutional cost and it would be a natural fit to align the budgetary needs of the plan with the budgetary realities and resources of the institution. Indeed, as Taylor and Karr noted in their study:

> "One criticism raised at nearly all the institutions studied was a failure to link the strategic plan to the budget. Planning disconnected from fiscal reality is like planning a sailing trip without a boat—one may lay out all of the places one wants to go, but the chances of getting there are slim to none."[24]

While some plans may reference the state of budgetary resources in their efforts to justify a reduction in services or an increase in facilities, many do not provide the budgetary detail or blueprint to adequately demonstrate how the ideals and aims of the plan will be realized. This is another critical factor in analyzing strategic plans in relation to research outcomes and productivity, since providing participants and stakeholders with the budgetary guidance to support plan achievement would be a natural pairing. Hinton expands further in showing that:

> "For institutions that budget without a strategic plan the tendency is to make budget-based decisions leading to incremental change rather than strategic change: the institution only improves or changes as the budget allows. In addition, major changes and initiatives are viewed as an addition to the current budget. The notion of reallocating resources based on planned change requires a vision that provides context for the budget…[and] [t]he comprehensive context is crucial to ensuring budget resources are allocated appropriately in support of the institutional mission and vision."[25]

The literature illustrates the importance of budgetary alignment and inclusion in strategic plans and planning processes for research universities to equip their participants and stakeholders with the supportive tools and information that provide the greatest opportunity for success.

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[24] Ibid., 230.
[25] Ibid., 35.

2.4: Prior Studies Related to Strategic Planning in Research

Several previous studies have been conducted which examine the use of strategic planning in research universities. Each study provides a unique insight into both the effects of strategic planning in the university environment and the current research questions and methods being used within the field. Collectively, these studies provide a foundation for the research of this paper and a further understanding of the methods and effects related to the subject.

Morphew, Fumasoli and Stensaker

The 2018 study, *Changing missions? How the strategic plans of research-intensive universities in Northern Europe and North America balance competing identities*, by Christopher Morphew, Tatiana Fumasoli and Bjørn Stensaker, examined "the assumption that public research-intensive universities are conforming to external pressures and demands in similar ways [b]y analyzing the strategic plans of public research-intensive universities in Northern Europe and North America."[26] The study examined 19 universities, eight of which were located in the United States, including one that is also within in the focus of this paper. The study utilized a uniquely interesting method of analyzing their sample of strategic plans using "Pratt and Foreman's (2000) frames to assess whether the strategic plans of research-intensive universities in Northern Europe and North America provide evidence of similar ways of using compartmentalization, deletion, integration, or aggregation as organizational responses."[27] Adopting the psychological and sociological study of multiple identities existing within the individual, Michael Pratt and Peter Foreman developed a framework to understand "how

[26] Morphew, C. C., Fumasoli, T. & Stensaker, B. (2018). Changing missions? How the strategic plans of research-intensive universities in Northern Europe and North America balance competing identities, *Studies in Higher Education, 43*(6), 1074-1088, accessed Spring 2019, DOI: 10.1080/03075079.2016.1214697
[27] Morphew, C. C., Fumasoli, T. & Stensaker, B. *Changing missions?* p.1077.

organizational leaders or managers can manage multiple conceptualizations about "who are we" as an organization."[28]

In the first response, labeled *Compartmentalization*, in the Pratt and Foreman framework, an organization, in the case of the specific study a university, may choose to acknowledge and retain its multiple identities without seeking to establish a *synergy* between them. In the second response, *Deletion*, a university, perhaps facing intense budgetary constraints, may choose to eliminate one or more identities in favor of focusing attention and resources to those that remain. In the third response, *Integration*, a university may seek to weld its multiple identities into a single unified vision of their collective identity unit. The fourth and final response, *Aggregation*, would allow the university to maintain its individual identities while, in contrast to compartmentalization, promoting open communication and collaboration between them to develop a working synergy.[29]

The Morphew, Fumasoli and Stensaker study, provides a direct connection to the subject of this paper as its "main argument for focusing on strategic plans and documents is that strategic planning has become a ubiquitous process in higher education, ostensibly linked to universities' unique characteristics, long-term goals, and resource allocation,"[30] thereby highlighting the use of strategic plans as a tool for analyzing university research.

Morphew and Baker

In their 2004 study, *The Cost of Prestige: Do New Research I Universities Incur*

[28] Pratt, M. G., & Foreman, P. O. (2000). Classifying Managerial Responses to Multiple Organizational Identities. *Academy of Management Review*, *25*(1), 18–42, accessed Spring 2019, https://doi-org.proxy1.library.jhu.edu/10.5465/AMR.2000.2791601
[29] Pratt, M. G., & Foreman, P. O. *Classifying Managerial Responses*, p.26-35.
[30] Ibid., 1079.

Higher Administrative Costs?, Christopher Morphew and Bruce Baker, explored the institutional costs to universities aspiring to increase their Carnegie Classification from the Research 2 (RU2) to Research 1 (RU1) level. Morphew and Baker's aim was to explore the whether new RU1 universities had to increase their expenses to make the move to the higher classification, and if they had to sustain those increased costs. Their study analyzed institutional financial data for 88 RU1 universities and 37 RU2 universities for the year 1994 and compared the data for the same universities going back to the years 1976, 1988, 1992, and 1996. This allowed them to analyze how the expense costs were adjusted during the RU1's progress from RU2 status compared to RU2's that were currently working to rise as well.

Their study showed "mixed support for the claim that universities reaching the pinnacle of research university status experience increase administrative costs as a result of their aspirations and the realities of their new stature," while at the same time showing that RU1's did change in terms of their expenses.[31] This study illustrated both the ability and complexity of using university financial data in relation to organizational changes in research status.

2.5: Indicators used to Measure Research Productivity

Defining an Indicator

Measuring research is a complex and multi-faceted endeavor faced with an imposing amount of variability resulting from a host of distinct elements which can often be simultaneously independent yet complexly intertwined. Established systems of measuring research activity and productivity make use of various indicators defined by their interactions

[31] Morphew, C. C. & Baker, B. D. (2004). The Cost of Prestige: Do New Research I Universities Incur Higher Administrative Costs? *The Review of Higher Education* 27(3), 365-384. Johns Hopkins University Press, accessed Spring 2019, *https://muse.jhu.edu/article/53329*

with one another and their influence on the dynamic forces of the research enterprise. Offering a solid definition of an *indicator*, Cassidy Sugimoto and Vincent Larivière explain that:

> "In social research – as in the measurement of research – the quantification of concepts is made through the creation of indicators. The measurement of research is derived from… noting that unobservable variables (such as research production and scientific impact) can be quantified in terms of observable, and, thus, measurable, variables (e.g., number of papers and citations). Indicators, therefore, focus on the observable phenomena of the research enterprise, in a manner that seeks to make manifest the unobservable in research."[32]

In essence, indicators are defined by observable research related products which are then measured in comparison to obtain a quantifiable measurement of intangible concepts. Unlike the traditional business market, where product sales provide direct and tangible units of measurement, scientific and academic research trades in the production of knowledge and discovery sharing, which requires the need for a conceptually based measurement scale.

Types of Indicators used to Measure Research

The types of indicators used for measuring research activity and productivity often depend on the specific components of the research process that are being examined and measured for a specific study. Indicator selection is determined by the questions or inquiries that drive the scope and design of the study being conducted. While indicators can be customized to fit the parameters of the study design, a standard set of defined indicators has been established for wider use in measuring research activity and productivity. The standard indicators widely accepted and used throughout the literature include indicators such as publication and citation

[32] Sugimoto, C. R. & Larivière, V. (2018). *Measuring Research: What Everyone Needs to Know*. New York, NY: Oxford University Press. p.14-15.

counts, research funding and awards, collaborations, faculty counts and demographics, institutional staff and financial investment, and commercialization revenues related to intellectual property development, just name a few. In his recent book, *Applied Evaluative Informatics*, Henk Moed demonstrates how these indicators can be categorized into four major components detailed in Table 2.1, which include input, output, process, and impact.[33]

Component	Sub-component	Typical Indicator Examples
Input	Funding and Personnel	Available Funds
		FTE Academic or Research Staff
	Research Infrastructure	Total R&D Investment
		Value of infrastructure and Facilities;
		Research Active Academics
		Total Research Funding or Awards
	Sustainability and Scale	Postgraduate Research
		Early Career Investigators
		Number of Collaborations and Partnerships
Output	Scientific/Scholarly	Number of Journal Articles or Book Chapters
		Research Data Files
Process	Efficiency	Number of publications per FTE academic staff
	Collaboration	Number of Collaborations and Partnerships
Impact	Scientific/Scholarly	Citation Impact
		Prizes and Awards
	Societal	IP Commercialization

Table 2.1: Indicator Component Categories based on H. Moed, *Applied Evaluative Informatics*[34]

[33] Moed, H. F. (2017). *Applied Evaluative Informatics*. Cham, Switzerland: Springer International Publishing, p.46.
[34] Moed, H. F. *Applied Evaluative Informatics,* p.46-50.

Chapter 3: Problem Statement

Research is a complex enterprise involving a varied mixture of factors that influence how each institution fairs as they navigate the calms and tempests that define the business of scientific research. Throughout the academic research enterprise, as competition increases, and funding becomes more difficult to obtain, the prevailing trend is for many institutions to reduce their institutional budgetary support and resources, relying more on their investigators to continue the fight and press-on for more funding and continue to produce research outcomes and impact. Despite the variable options of infrastructure and institutional indicators that can be leveraged by leadership to meet the commonly strived for goals of increasing research funding and production, an understanding of where correlations exist is needed for leadership to build effective strategies based on statistical data over budgetary reactions. This research aims to explore the complex variables involved in strategic planning for research institutions and identify those that have been shown to correlate with the successful achievement of common institutional research goals.

Chapter 4: Methodology

The research project for this thesis aims to explore the effect of institutional strategic planning on research productivity and outcomes in universities classified as engaging in high – very high research activity. In addition to examining the selected indicators based on analysis of the sampled strategic plans, particular attention to institutional support structures, through financial investments in administrative support budgeting, administrative support staffing, and institutional infrastructure, is a central element of the project's scope.

4.1: Research Design

Sample Selection

The design of this research project began with a search of strategic plans from a mixed sampling of universities classified at the time of their strategic plan as having doctoral programs with high – very high research activity by the Carnegie Classification of Institutions of Higher Education.[35] As shown in Table 4.1, the result was a sample of 13 universities consisting of 5 public doctoral universities with High Research Activity (HRA), 5 public doctoral universities with Very High Research Activity (VHRA), and 3 private doctoral universities with Very High Research Activity (VHRA). Sample selection was limited to those universities within the

Public – High Research Activity	Public – Very High Research Activity	Private – Very High Research Activity
Texas State University	Ohio State University	Cornell University
Texas Tech University	University of Hawaii	
University of Alaska Fairbanks	University of Kansas	Johns Hopkins University
University of Maine	University of Kentucky	Northwestern University
University of Massachusetts Boston	Washington State University	

Table 4.1: Sample of research universities based on their Carnegie Classification at the time of strategic plan implementation.

[35] Carnegie Classification of Institutions of Higher Education by Indiana University Center for Postsecondary Research. (2019). accessed Spring 2019. http://carnegieclassifications.iu.edu/index.php

Carnegie Classification in which strategic plans had been implemented between the five-year period of 2008-2013 and were made publicly available.

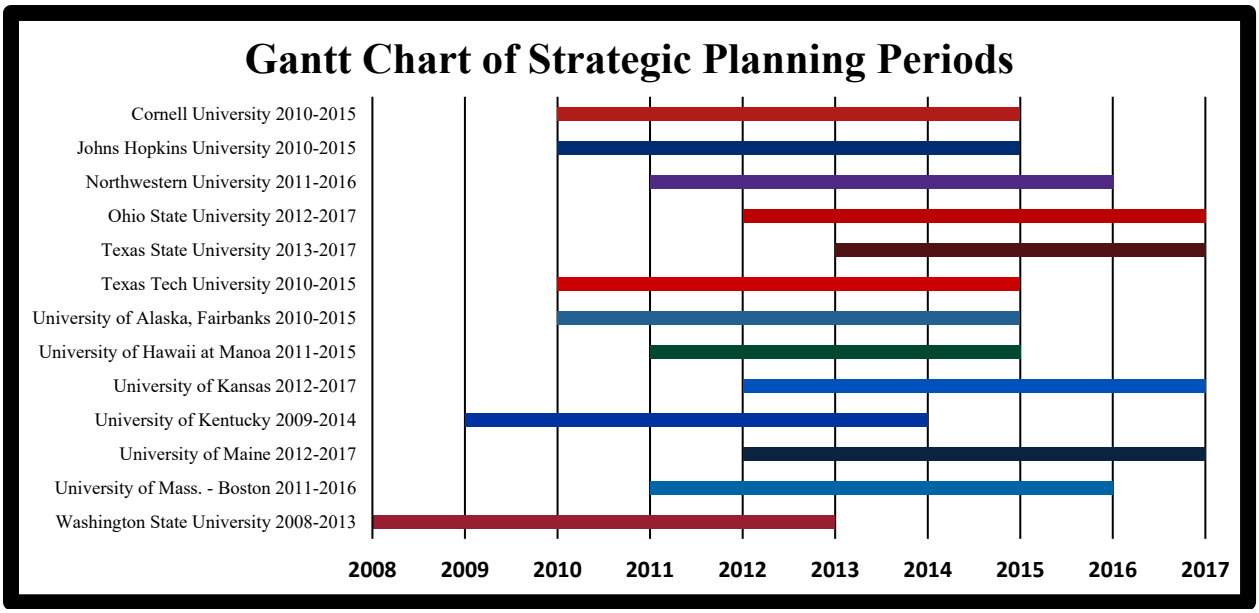

Figure 4.1: Gantt chart of strategic planning periods

Content Analysis

To determine the appropriate themes related to the research enterprise within the university setting, and to aid in defining the appropriate indicators that would be used for measurement, a conceptual content analysis was applied to the strategic plans of each university. Content analysis is a widely used method throughout the social sciences for analyzing and codifying text to identify specific patterns or themes.[36] Table 4.2 details the three main concept categories derived from the content analysis of the strategic plans. Format distinguishes between the two main format types found among the strategic plans created by the universities in the sample, which identified those that were text-based documents, which read like a traditional narrative, and those that were visually based documents, which took more of a marketing-based

[36] Busch, C., De Maret, P. S., Flynn, T., Kellum, R., Le, S., Meyers, B., Saunders, M., White, R., & Palmquist, M. (1994 - 2012). Content Analysis. Writing@CSU. Colorado State University. accessed Spring 2019, https://writing.colostate.edu/guides/guide.cfm?guideid=61.

approach. The latter of the two formats relied more on visual aids, such as pictures of the campus, faculty or students, and used a lighter outline format to relay the message of the text.

Format	Elements	Themes
Text Based	Goals / Objectives	Increase Funding
		Recruitment
	Strategies	Collaboration
Visual Based		Support / Infrastructure
	Metrics	Staffing
		Culture
	Budget	Industry

Table 4.2: Content analysis codifiers for university strategic plans

Defining Indicators

Indicators to be used in measuring the research activity and productivity were based off the themes defined during the content analysis of the sampled university strategic plans. The selection of specific indicators was made in-line with those established in the field literature for measuring research activity and productivity. As discussed previously in the literature review, these indicators represent the accepted standard for measuring research input, output, impact, process, and infrastructure.

Themes	Indicators
Increase Funding	Total R&D Expenditures
	Federal R&D Obligations
	NIH Funding
Recruitment	Amount of New Hire Faculty
Collaboration	Amount of Collaborative Publications
Infrastructure, Support & Staffing	Value of Plant, Property and Equipment
	Institutional Support Expenses
	Research Support Expenses
Staffing	Total FTE
	Total Primary Research Staff
Industry	Number of Patent Applications

Table 4.3: Defined indicators based on content analysis themes

Data Collection Sources

This research project was designed to use publicly available data sources for its data analysis. Public access to many forms of data relevant to university research has continually increased over the years with many universities providing their own open access systems and data reports. The ease-of-use of online databases, both public and privately funded, has also improved, making data collection less cumbersome and more intuitive. One aspect of this research project was to demonstrate the ability for research administrators or organizational planners to be able to access and utilize data for institutional research and strategic planning without the need for costly systems, subscriptions, or consultants.

Specific data collection sources for this project included use of the Higher Education Research and Development (HERD) Survey[37] for data related to total R&D expenditures and federal R&D obligations, available from the National Science Foundation (NSF), and the Research Portfolio Online Reporting Tools (RePORT),[38] available from the National Institutes of Health (NIH), for data related to NIH funding. Data related to publications and citations, was accessed using The CWTS Leiden Ranking,[39] which provides bibliometric data for a global range of higher education institutions. Institutional data related to financial support, facilities and infrastructure, faculty recruitment, and staffing, was collected using reported data from the Integrated Postsecondary Education Data System (IPEDS),[40] available from the National Center for Education Statistics (NCES). Data related to U.S. patent applications assigned to the sampled

[37] National Science Foundation. National Center for Science and Engineering Statistics, *Higher Education Research and Development Survey, Fiscal Year 2017*, accessed Spring 2019, http://ncsesdata.nsf.gov/herd/.
[38] National Institutes of Health. *Research Portfolio Online Reporting Tools (RePORT)*, accessed Spring 2019, https://report.nih.gov/index.aspx.
[39] Leiden University. *The CWTS Leiden Ranking 2018*. accessed Spring 2019, http://www.leidenranking.com/
[40] Institute of Education Sciences, National Center for Education Statistics. *Integrated Postsecondary Education Data System (IPEDS)*, accessed Spring 2019, https://nces.ed.gov/ipeds/use-the-data

universities, was collected using Google Patents,[41] which was selected due to the non-user-friendly and antiquated data platform provided by the United States Patent and Trademark Office (USPTO).

While every effort was made to use data from publicly available sources, three universities in the sample, which include Texas State University, University of Maine, and University of Massachusetts, Boston, were not available in The CWTS Leiden Ranking database. For these three universities, publication and citation rates were accessed using InCites Essential Science Indicators, made available through the Johns Hopkins University Library system.[42]

4.2: Statistical Methods

The application of statistical methods to a research project investigating the effects of strategic planning related to measuring research performance presents several challenges. As Dooris, Kelley and Trainer note:

> "Strategic planning in a college or university occurs in a complex, dynamic, real-world environment, not readily amenable to controlled studies, or even to quasi-experimental designs. It is difficult to parse out the measurable effects of strategic planning from the influences of such other important factors as institutional leadership, demographic change, fluctuations in state and federal funding, politics, the actions of competing organizations, social and cultural forces, and the like."[43]

Despite the complex web of intertwined influences exerted upon each of the various components within both the research enterprise and the academic institutional structure, a two-part statistical

[41] Google Patents. (2019), accessed Spring 2019, https://patents.google.com/
[42] Clarivate Analytics. (2019). InCites Essential Science Indicators. accessed through the Johns Hopkins University Library in Spring 2019, https://esi-clarivate-com.proxy1.library.jhu.edu/IndicatorsAction.action
[43] Ibid., 9.

analysis was conducted along the trends that were witnessed in the data for the time-periods examined under the sampled strategic plans.

Data related to the indicators was gathered and recorded for each year of examined strategic plan periods for each university, using both total raw numbers and adjusting to the use of proportional percentage to provide a more comparable view between universities. Indicators were then defined as either independent variables or dependent variables. Since the aim of the project was to investigate the institutional effect of strategic planning on research performance, the directional relationship between the indicators was mapped using a relational framework between those determined to be input, output, impact, and infrastructure/scale related. Figure 4.2 illustrates the mapping of relationships, in which indicators related to institutional infrastructure and scale act as independent variables in relation to those within the input, output and impact components defined as the dependent variables. However, outside of the infrastructure and scale indicators, the relationships connecting those within input, output and impact can alternate between the influencing states of acting as both independent and dependent variables. For example, research funding decisions are often influenced by the publications, citations, collaborations and patents that are associated with principal investigators and their proposals; while in-turn, funding also influences publications, citations, collaborations and patents by serving as the engine that drives research direction.

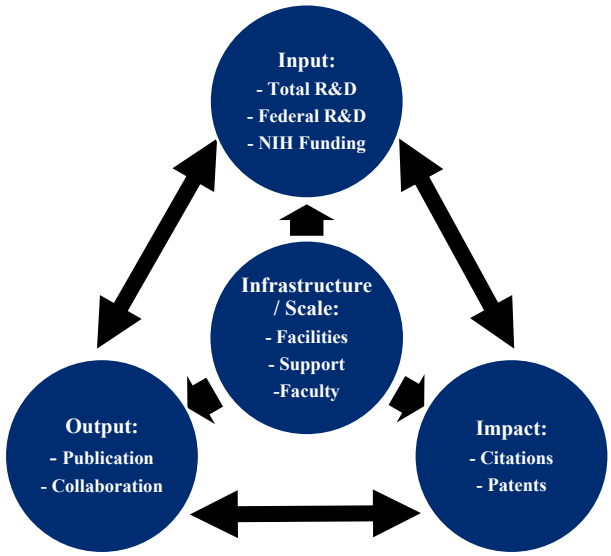

Figure 4.2: Relational framework between indicators

Using the statistical data analysis tools within Microsoft Excel 365 to explore connections between the indicators, a statistical analysis using the Pearson Correlation Coefficient method was first conducted to explore the presence of basic correlations between the indicator variables. For those variables that were found to be correlated using the Pearson method, a second statistical analysis was performed using linear regression to determine the strength of the correlations and if they were found to be statistically significant.

Chapter 5: Data Analysis & Results

Early in the project it became clear that the amount of data and the interconnectivity of the variables would present a cumbersome challenge to organize. The content analysis conducted on the thirteen strategic plans created thirteen category groups, each with a unique set and quantity of universities. The data quickly began to extrapolate from that point with each new variable. The data analysis will be presented by first outlining the content analysis results, followed by a comparison of the research productivity outcomes between the various groups, and then an analysis of the Pearson Correlation method and linear regression results throughout the sample.

5.1: Content Analysis Results

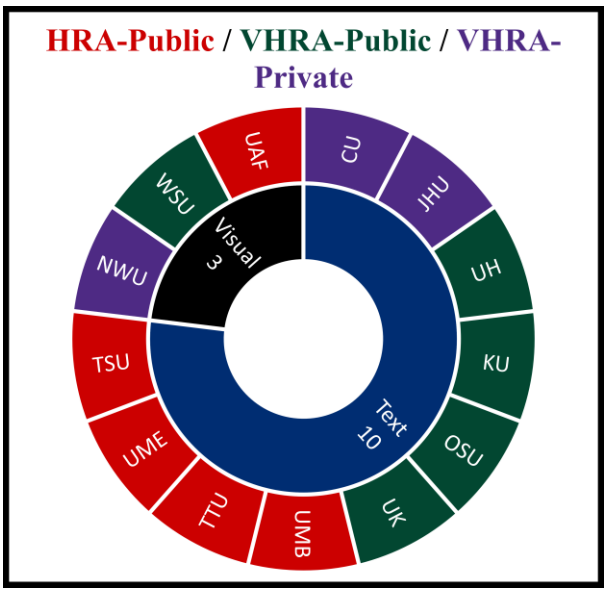

Figure 5.1: Results of Content Analysis for Format

The content analysis began by reading each of the sampled university strategic plans with specific focus on research. As detailed earlier in Table 4.2, the content analysis revealed three main categories, including Format, Elements, and Themes, each with multiple sub-categories. The first category, Format, divided the strategic plans among those which were primarily text-based documents and those which were prepared in a more visual format. Figure 5.1 illustrates the ten university strategic plans that were text-based and the three that were visual, with red indicating universities classified as public HRA, green as public VHRA, and purple as private VHRA. It was obvious

that the primary format used in the sample was a text-based document, with only three universities having produced a visual style format.

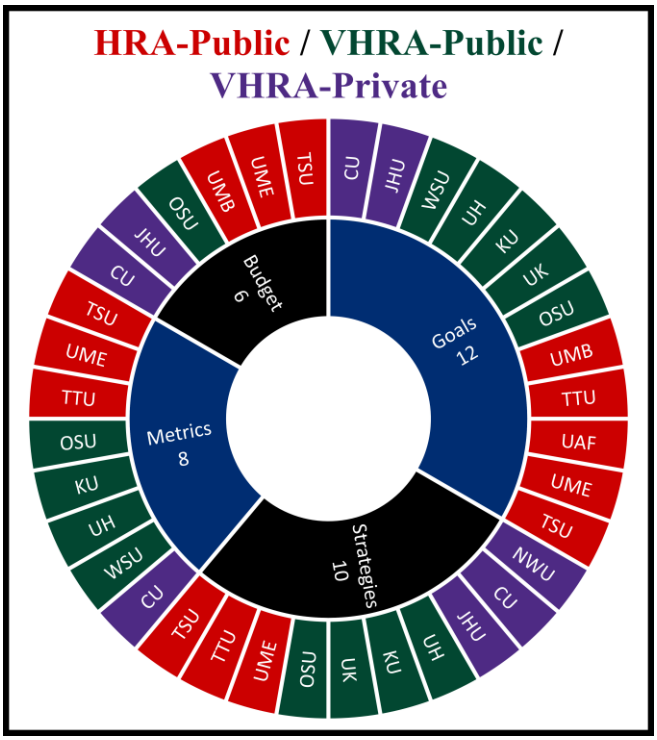

Figure 5.2: Results of Content Analysis for Elements

For the second category of the content analysis, Elements, four sub-categories were identified, which included strategic plans that incorporated specifically defined goals, strategies, metrics, and those that included budgetary details. This last sub-category regarding the inclusion of the university budget in relation to the goals and objectives of the strategic plan, was identified in the literature as being a key component for tethering the ideal vision with the financial ability for it to be realized. Figure 5.2 illustrates the groups of universities that fell into each of the four sub-categories. It was immediately clear that all but one university in the sample, Northwestern, included defined goals. Strategies were also common among the strategic plans, with ten universities having included them. Eight of the thirteen in the sample indicated specific metrics for measuring their progress toward meeting their goals or objectives, while six universities, slightly less than half, included their budgetary capabilities. Each of the three classification groups were represented in all four sub-categories.

In the third category of the content analysis, Themes, seven sub-categories were identified as common themes for research in the strategic plans of the sample. Figure 5.3 illustrates the university grouping for each of the seven themes. The most common theme among

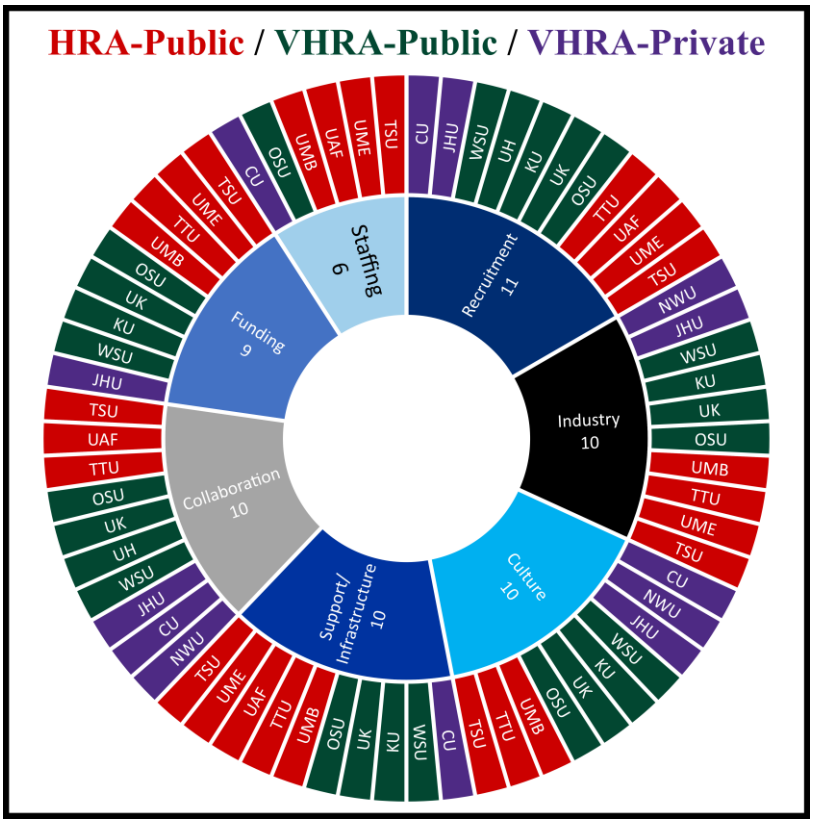

Figure 5.3: Results of Content Analysis for Themes

the strategic plans in the sample was the university's desire to increase recruitment efforts, with three-quarters of the universities including recruitment as part of their plan. This was not exactly surprising since many universities see the recruitment of new faculty as perhaps the most expedient method of increasing research productivity and funding. While the majority of the recruitment focus was aimed toward faculty, some universities did include the recruitment of administrative support staff and leadership. Four themes were equally represented with 10 universities each, which included the topics of industry and commercialization, collaboration most often aimed at interdisciplinary and interinstitutional research, increasing institutional support and infrastructure, and fostering a university or research culture. While still included in two-thirds of the strategic plans sampled, it was a surprise that specific mention of increasing research funding was only identified in nine of the thirteen universities. Considering that the increase of research funding, especially federal funding, is the consistent goal that research institutions and research administrators strive for, this was expected to be seen in every strategic plan. The theme with the lowest number to be included in research university strategic plans was specific mention of administrative or support staffing. Six universities in the sample

identified a need or plan to increase administrative or support staff positions as part of their priorities for enhancing their research enterprise. It is interesting to note the observation that five of the six identified for the theme of staffing were also five of the six identified for the element of budgeting.

5.2: Initial Group Comparisons

The purpose of conducting the content analysis of the strategic plans was two-fold. First, it provided insight into the goals, strategies, methods, and areas of interest in research that are common across research universities. The insight gained provided direction on the development of indicators, variables and analysis necessary for the project. Second, while it showed the elements and themes common across the plans, it is also highlighted some areas where differences exist between the universities strategic planning and thinking. Examining the groupings of the content analysis exposes four areas where the sample was divided, which include the text versus visual based formats, the use of metrics, the inclusion of institutional budgets, and the desire to increase support staff. These groups were examined to see how they compared in terms of their research outcomes in funding, publications, and citations.

Text versus Visual Format

The universities that used a text-based format versus a visual format were not as divided as the other three, however the stark difference in formats and content, with visual plans having much less detailed content providing more of an outline as opposed to a narrative, called for a closer look. Specifically, the question was whether universities who used each format experienced high levels of research outcomes compared to the other. Figure 5.4 shows the comparison between the three universities, NWU, UAF, and WSU, who used a visual-based approach and their overall proportional percentage of increase or decline in outcomes over the

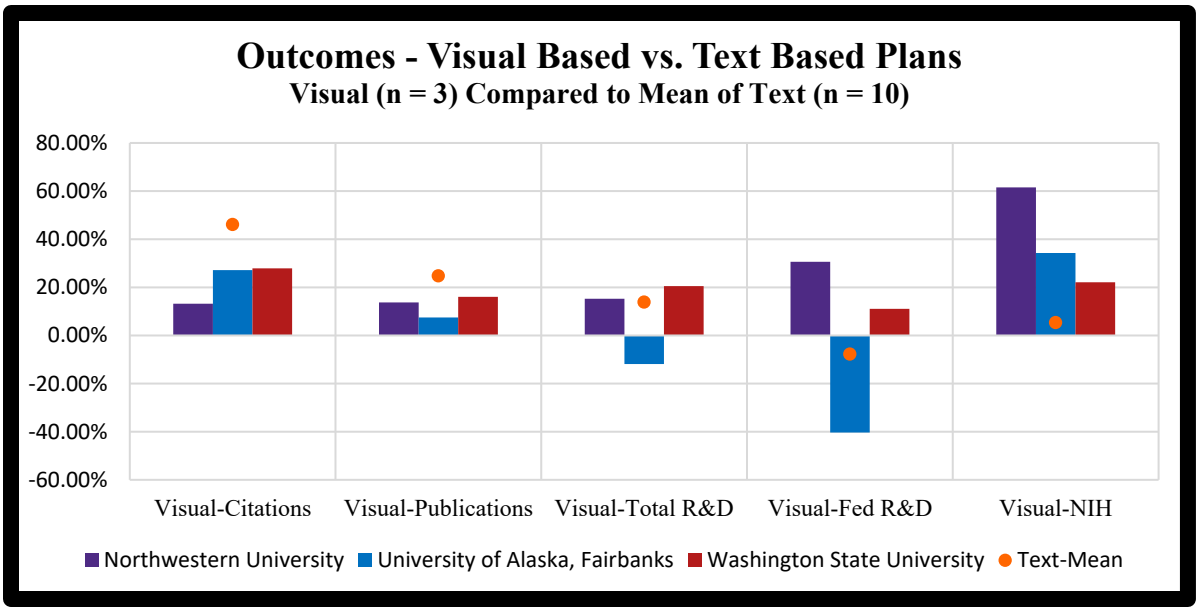

Figure 5.4: Outcomes for Text vs. Visual Strategic Plan Formats

years examined of the strategic plan, compared to the mean of the ten universities using text-based plans. All three experienced increases in publications and citations that were below the mean of the text-based group. Citation rates saw the largest difference, with WSU having the greatest increase of the three experiencing a 27.86% increase in citations, which was still 18.25% below the text-based mean. Differences in funding however, were not as clearly favorable to one group or the other. Both NWU and WSU saw increases in total R&D expenditures that were above the text-based mean, while UAF saw an overall decline by -11.88%, which was 25.75% below the mean of the comparison group. Federal funding obligations showed the same pattern as total R&D, while all three showed increases in NIH funding that were well above the text-based mean. While the difference in sample sizes between the two groups is a limiting factor in this analysis, it does appear that clear distinctions cannot be made in determining that one format is more influential than the other in producing research outcomes.

Metrics

The inclusion of metrics for measuring progress and strategic plan goal achievement, was included in the plans of eight universities, while the remaining five did not define specific

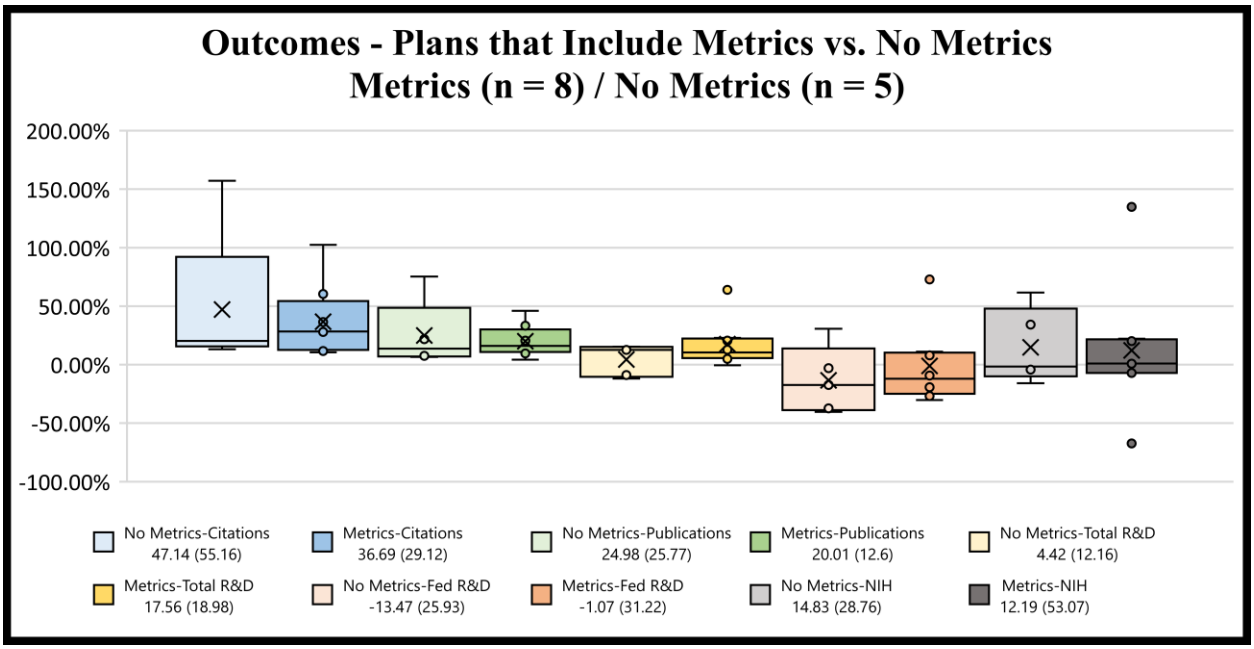

Figure 5.5: Outcomes for Plans with Metrics vs. No Metrics

metrics. Since the two groups were closer in sample size, compared to the text/visual comparison, a box and whisker plot was used to view how the research outcomes were distributed within each group. Figure 5.5 illustrates the five-number summary used to create the box and whisker plot, with the mean and standard deviation listed for each outcome in the legend. The five-number summary includes the lowest value, the first quartile, the median, the third quartile, and the highest value of the data set. Figure 5.5 also includes the mean for each data set which is indicated by an "x" in the box plot, as well as any outliers which are indicated as a dot outside of the box plot. The graphical representation provided in Figure 5.5, shows that the two groups did not experience a large difference in research outcomes related to publications or citations. One explanation for this could be due to the majority of metrics being focused on funding or personnel, with little specific attention to publications or citations. For funding outcomes, Figure 5.5 shows that total R&D expenditures did slightly favor the group that included the use of metrics in their plans, while federal obligations and NIH funding did not see a distinct difference between the groups. One interpretation for why funding outcomes were not

overly favored by one group or the other, could be related to the difficulty in assigning direct influence over funding rates to any one component of an institution's research enterprise, since there are many factors, both internal and external, that influence funding. So, while defining specific funding targets may provide the institution with the direction and pace desired by leadership, the factionalization of influences may not allow enough direct control over the rate of funding achieved.

Institutional Budgets

The decision to integrate institutional finances with the goals and objectives of a strategic plan could be viewed as the dividing line between idealism and pragmatism. Reviewing the literature showed this to be an important part of strategic planning and was included in six of the university strategic plans in the sample. This resulted in an almost even divide of the sample between the two groups, allowing for a good comparison using the box plot graphical representation format. Figure 5.6 illustrates the compared research outcomes for both groups and

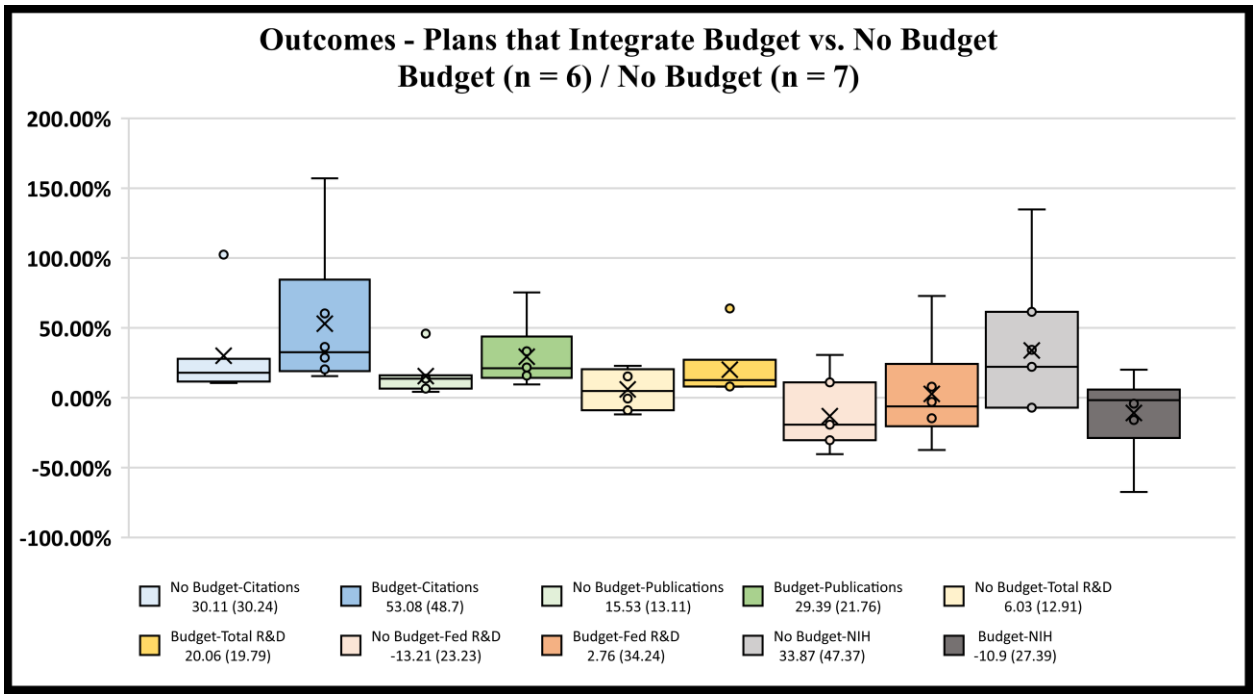

Figure 5.6: Outcomes that Integrate Budget vs. No Budget

includes the means and standard deviation for each outcome in the legend. Figure 5.6 quickly shows that the universities that integrated their institutional budgeting with the priorities of their strategic plans, experienced higher rates in almost all the research outcomes. The most pronounced differences were seen in the citation and publication rates, where the group that included budgeting had both a higher mean of proportional increase and a higher range of increase in the data. Increases in total R&D expenditures were also higher for those that included budgeting, with all six universities having rates above the mean of the comparison group. Federal R&D obligations were also higher in the budget group, although the difference was less apparent than the previous three outcomes. The only outcome that did not favor the budgeting group was NIH funding, which was higher for the group without budgeting. However, overall, the comparison between the two groups within this sample shows that universities that provided financial rationale to the priorities of their strategic plans experienced higher rates of research outcomes in both publication output, citation impact, and funding input.

Administrative and Support Staffing

Institutional administrative and support staffing is one of the greatest fiscal challenges that research organizations face. Research is an ever increasingly expensive operation and the indirect costs provided through research funding are rarely enough to fully sustain an institutional research enterprise. The decision to increase administrative or support staff for research is often made in the hope that additional support will increase the productivity and competitiveness of their faculty and investigators, which in-turn would result in higher success rates for research funding. Among the sampled universities, six included either direct plans or discussion regarding the need to increase administrative or support staff. Interestingly, four of the six were part of the public HRA group, with one each from the public VHRA and private

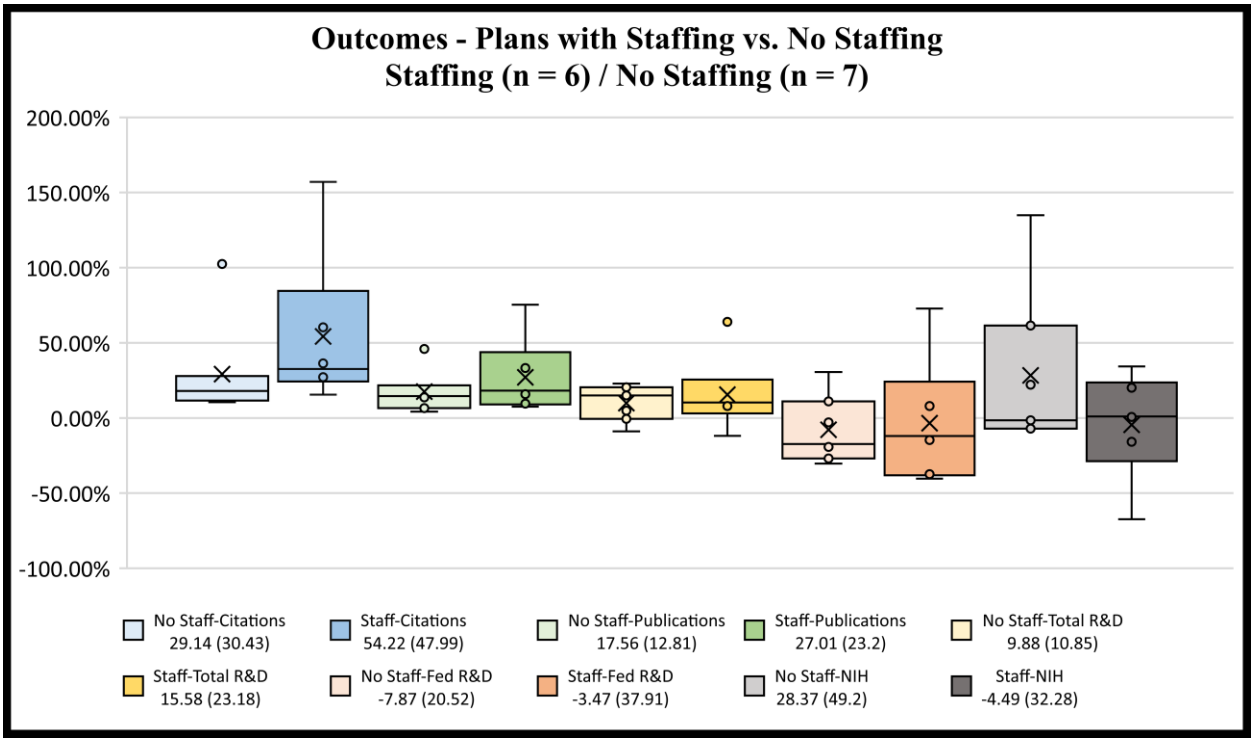

Figure 5.7: Outcomes for Plans that Include Staffing vs. No Staffing

VHRA classified groups. This is not overly surprising given the motivation of the HRA universities to reach the VHRA classification, which would necessitate investment in an overall expansion of their research enterprise.

Figure 5.7 presents the box plot graphical representation of the rates of research outcomes between the six universities that included staffing in their strategic plans compared to the seven that did not. Since five of the six in the staffing group were also five of the six in the budget group, as would be expected, the results between the two were highly similar, with the largest difference being found in the citation and publication rates. Funding rates in this comparison for the included staffing group were a bit lower than the budget comparison, which was related to the difference in the one unrelated university, with JHU included in the budget sample and UAF appearing in the staffing group. The stark divide between their research statures had an obvious effect, with JHU raising rates and UAF decreasing.

5.3: High-Level View

After examining the content analysis and comparisons, the project focused on investigating the specific correlations between the infrastructure and scale indicators and the research outcomes for each university and group classification. Before examining the statistical analysis results, it is important to have a high-level view of the external funding landscape during the time periods of the strategic plans being investigated for the sample. In addition to the external funding environment, a high-level view of the total proportional changes in external research funding and internal infrastructure is also important to witness before zooming in on the more specific correlations.

External Funding Environment

The research enterprise operates in concert with the rhythm of the external funding environment. Given the strength of its influence, it would be vital for any examination into an institution's research enterprise to first understand the contemporary external funding environment. Figure

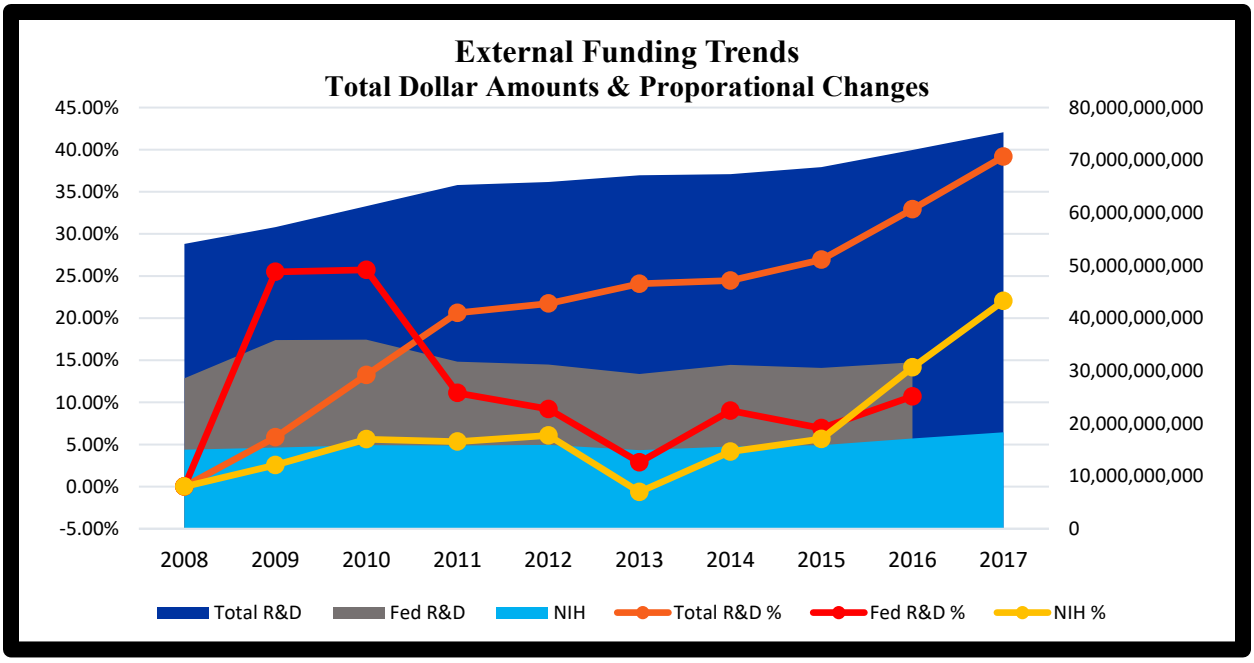

Figure 5.8: External Funding Trends 2008-2017

5.8 shows the funding trends for total R&D expenditures, federal R&D obligations, [44] and NIH funding,[45] that occurred between the years that encompass the strategic plans within the sample. The trends paint a turbulent picture for federal R&D, which experienced a 25.5% increase from 2008 to 2009 and then leveled-off for a year, with a gain of only 0.23%. But by 2013, the rollercoaster ride dropped 22.85%, fluctuating up and down thereafter. With the exception of a 6.7% drop between 2012 and 2013, NIH funding remained fairly stable, even seeing a steady increase after 2013. Interestingly, despite the ubiquitous decree of impending doom, total R&D expenditures enjoyed a steady increase every year, with an overall gain of 39.18% between 2008 and 2017. Given the corresponding ebb and flow of federal obligations and NIH funding, this would imply that despite the unease that federal funding may inflict, the research enterprise has been compensating with non-federal funding sources. In many respects, this illustrates the fortitude of research in its ability to withstand, although painful as it may feel, the fickleness of federal support.

Funding Results for Sampled Universities

Figure 5.9 highlights the overall rates of increase or decrease that each university in the sample experienced in the three funding categories over the course of the strategic plans examined. The universities are shown in ranking order by their overall change in total R&D, with changes to federal R&D and NIH funding shown by overlapping line graphs. Since both federal R&D and NIH funding each contribute to it, total R&D expenditures serve as the primary scale by which to view the overall funding outcomes. Looking at Figure 5.9, the clear research funding success story was TSU, with a total R&D increase of 63.93%, followed by TTU (22.9%)

[44] National Science Foundation, *Higher Education Research and Development Survey*.
[45] National Institutes of Health. *Research Portfolio Online Reporting Tools (RePORT)*.

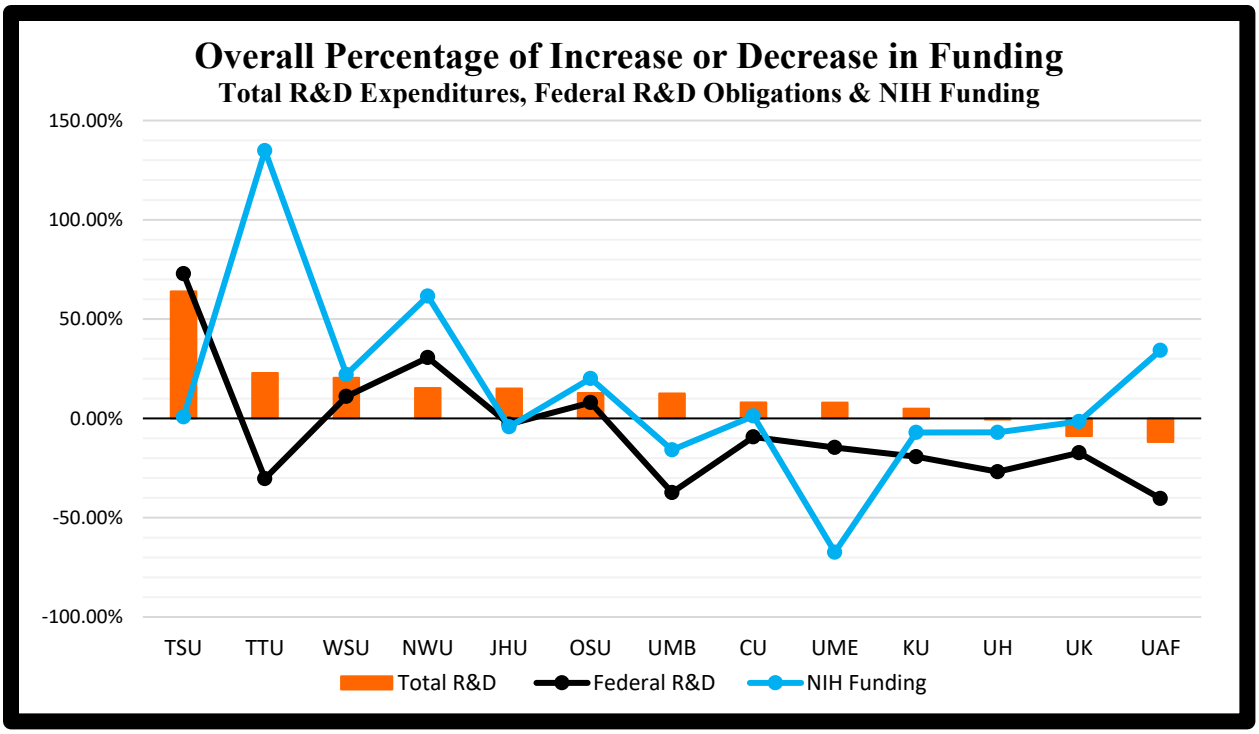

Figure 5.9: Overall Percentage of Increase or Decrease in Funding by University

and WSU (20.49%), to round out the top three. The majority of the sampled universities saw modest gains in total R&D, with only three, UH, UK, and UAF, suffering a decrease. Examining the corresponding trends in federal R&D and NIH funding, provides deeper insight into the composition of their change in total R&D. For example, TSU experienced a large increase in federal R&D (72.86%) but almost no change in NIH funding (0.76%), while the next one in line, TTU had a decrease in federal R&D (-30.31%) but a massive 134.84% increase in NIH funding. At the same time, while UAF increased their NIH funding by 34.28%, it was clearly not enough to overcome their decline of -40.33% in federal R&D, leading to a total R&D drop by -11.88%.

Relating the funding results of the sampled universities to their strategic plans, further demonstrates the complexities of understanding the forces that influence research outcomes. As illustrated in Figure 5.10, of the eleven elements and themes identified in the content analysis, TSU, which had the greatest increase in total R&D, included all eleven in their strategic plan. A connection between the two could be made, arguing that TSU's comprehensive strategic plan led

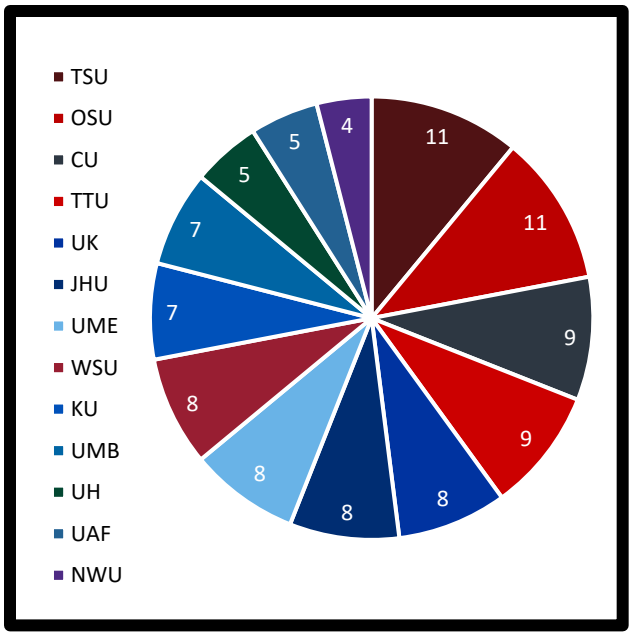

Figure 5.10: Number of the Eleven Content Analysis Elements and Themes by university

them to such an increase. However, NWU, while not quite as dramatic, enjoyed the fourth largest increase in total R&D, but had the lowest number in the content analysis, having included only four of the elements and themes in their strategic plan. Still, the three universities that fell into the negative for total R&D were also in the bottom portion of the content analysis, perhaps making NWU more of an outlier than an indicator.

Looking at the research funding outcomes in Figure 5.9 from the angle of the three Carnegie classification groups, shows a split field. The HRA group provided the bookends, with TSU and TTU taking the top two positions and UAF taking the last, while UMass Boston and UME held down the middle. The public VHRA group held the number three spot with WSU, and OSU in the sixth, while KU, UH, and UK filled three of the last four. The three universities of the private VHRA group seem to hold steady down the middle, with NWU in fourth, JHU in fifth, and CU holding the number eight position.

While there are any number of forces that could have influenced how each university arrived at their location in Figure 5.9, viewing it from the classification group perspective does provide some interpretation. Despite their residence in the middle of the sample, which was looking at their rate of change of the plan period, the three private VHRA universities hold the highest national ranks on the NSF survey of total R&D, with JHU consistently ranked number

one.[46] Holding steady for these three universities still means they are large, established research institutions and have the capabilities to sustain their leading positions. At the other end of the spectrum, the universities in the HRA group faced the challenge of having to climb a steep mountain to increase their standing in the research enterprise. Such a challenge would require a greater level of motivation and investment, which could explain their positions at both the top and bottom of the sample in terms of their research funding outcomes. This interpretation is supported by the content analysis of the strategic plans. TSU had one of the most comprehensive, detailed, and motivationally driven strategic plans in the sample, was at the top of the content analysis scale, and had the greatest increase in total R&D. In contrast, UAF had the greatest decrease in total R&D and fell in the bottom of the content analysis scale for their strategic plan. Although there are a complex host of influences involved, this example does support the idea that a well-designed strategic plan that includes institutional investment in both financial and personnel support, leads to greater success in the competition for research funding.

Publications & Citations

While funding is a research outcome that manifests as input to the institution, in the form of sustaining and constructing support, research productivity is often measured in the form of publications and citations. Figure 5.11 displays the total percentage of increase in publications and citations that each university experienced during the years of their strategic plan examined. In contrast to the wild ride of research funding, the number of publications increased at a steady and similar pace for the majority of the universities in the sample. In fact, the real drama only occurs for the top three, UMass Boston, TTU, and TSU. All three partners on the HRA classification team, each enjoyed large advances in their publishing output and major advances in

[46] Ibid.

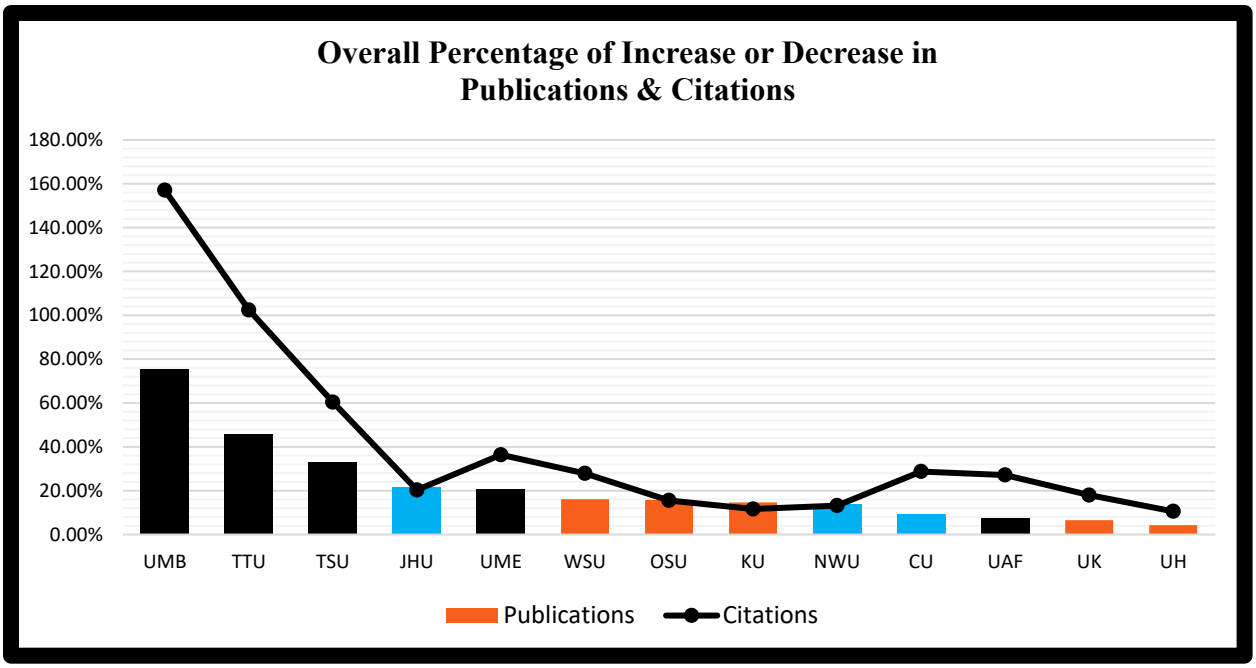

Figure 5.11: Overall percentage of increase or decrease in publications and citations by university

their citation rates. These achievements represent the outward contribution to the research enterprise through their publications, and their impact being made on the research community through their citation rates. Figure 5.11 also supports the view of the challenging and motivating influences that are involved with the universities in the HRA group as expressed in the previous section for funding. Overall, the steady increases across the sample show that despite the funding environment that they operate in, research universities continue to generate their influence and impact through publishing and having their work cited by peers.

Commercialization

Variables related to commercialization and industry sponsored research, are both complex and volatile. The level of commercialization and industry partnership depends heavily on the unique characteristics of the research institution and often requires specialized areas of focus and infrastructure to nurture and support its development. These factors make commercialization related variables difficult to fit into a model for analysis without designing the model and sample-set specifically around these specialized factors. Since industry partnered

research and commercialization interests were included in the majority of the strategic plans examined in this project, related variables, including patent applications and industry collaborative publications, were included in the analysis. However, since the universities included in this sample vary greatly in their focus and capabilities in this area, the results related to these variables should be utilized only to provide a general view of potential focus.

Figure 5.12 emphasizes this point, by visualizing the individual levels of commercialization related activity for each of the sampled universities, using the number of patent applications submitted per year over the course of the strategic plan periods. The chart highlights the difference in activity, with UAF, UH, and UMass Boston having little discernable movement, and CU, JHU, NWU, and OSU experiencing wide dispersions of action. The latter point further exposes the volatile nature of these variables, making them difficult to analyze outside of a dedicated study.

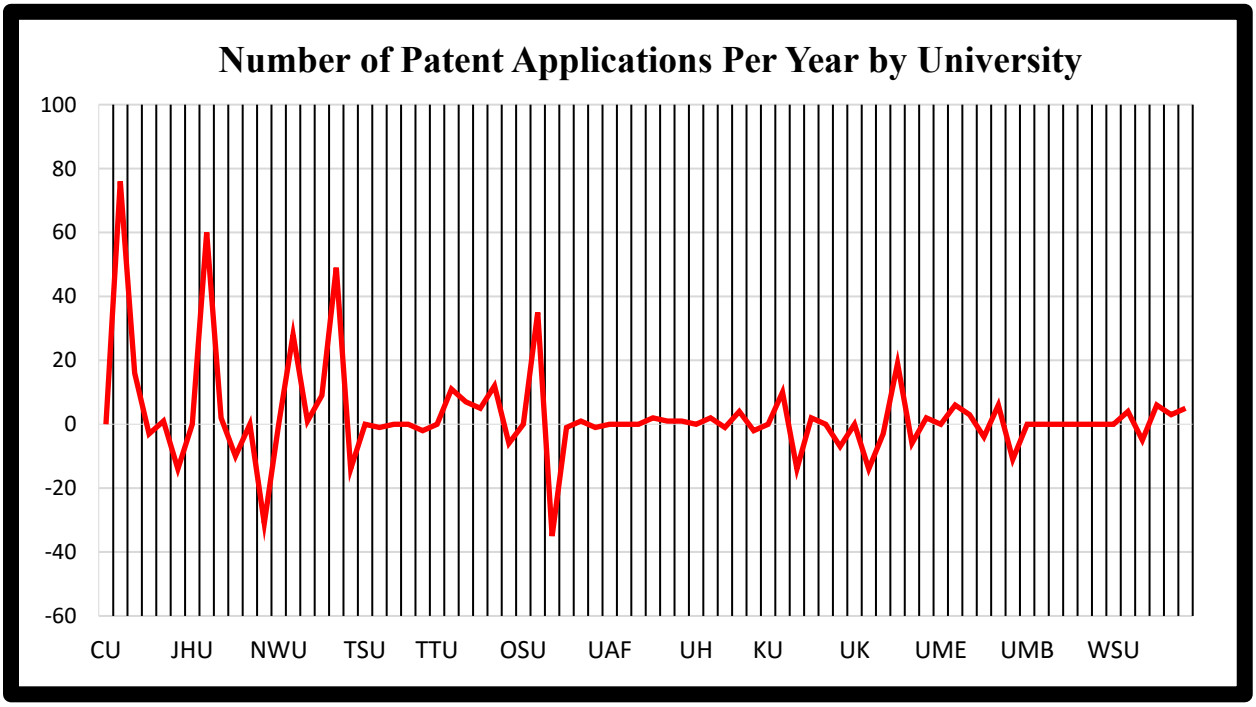

Figure 5.12: Number of Patent Applications per year by University

5.4: Statistical Analysis

The goal of the statistical analysis portion of this project, was to investigate any potential statistically significant correlations between variables related to infrastructure and scale, including institutional financial and personnel support, and research outcomes. Listed in Table 5.1 are the four financial and nine personnel variables, each of which were obtained from the

Financial Variables (IPEDS)	Personnel Variables (IPEDS)
Institutional Support	Research Staff
	Full Time Employees (FTE)
	Professors
Research Support	Associate Professors
	Assistant Professors
Total Core Expenses (TCE)	New Hire Faculty – Tenured (NHF-T)
	New Hire Faculty – Tenure Track (NHF-TT)
Plant, Property and Equipment (PPE)	New Hire Faculty – Non-Tenure Track (NHF-NT)
	New Hire Faculty – Total (NHF)

Table 5.1: Financial and Personnel variables used for infrastructure and scale – obtained from IPEDS survey data

IPEDS survey data (see Appendix A for specific IPEDS definitions).[47] As described in Section 4.1, the analysis also included research funding data from NSF and NIH, publication data from The CWTS Leiden Ranking and InCites Essential Science Indicators, and patent application data from Google Patents.

Overall Sample Analysis

Statistical analysis began by using the Pearson Correlation method to identify any correlations between the variable for each university in the sample. Variables that were identified with correlation values of $r^2 > 0.65$, were then tested using linear regression analysis. Results that returned a p-value < 0.05, were used to reject the null hypothesis and determine that a statistically significant correlation exists between the variables. During each test, residual plots

[47] Institute of Education Sciences, National Center for Education Statistics.

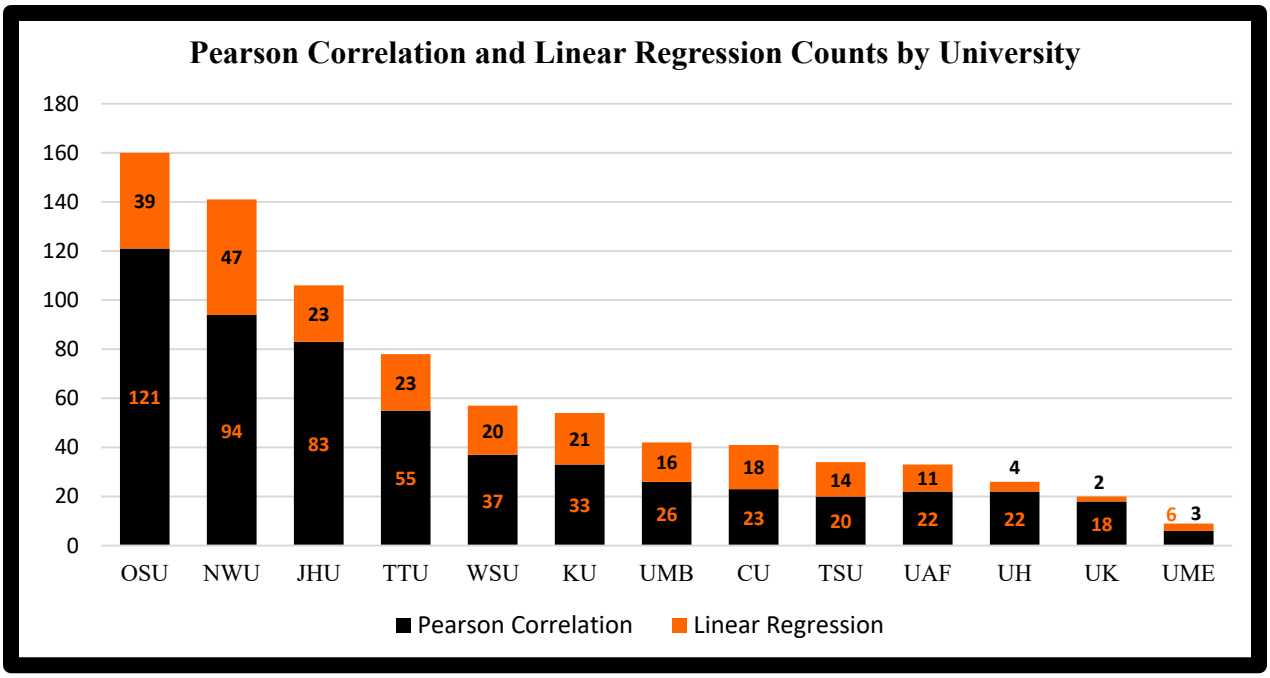

Figure 5.13: Pearson and Linear Regression Counts by University

were examined in an effort to ensure reliability. Tests that returned qualified r^2 and p-values but showed distinct patterns in the residual plots, were not identified as reliable and were therefore, not indicated as significant.

Among the thirteen universities in the sample, 560 correlations were identified using the Pearson Correlation method, of which 241 were identified as being significantly correlated (see Appendix II). Figure 5.13 shows the number of initial Pearson correlations and the number of those identified as significant by the linear regression analysis, for each university in the sample. Interestingly, the ranking order in Figure 5.13 shares several similarities with Figure 5.9, showing research funding outcomes. Comparing the two charts, four universities retained the same position in both, and only two moved between the upper and lower half of the sample. UMass Boston occupied the median in both charts, serving as the divide between the upper and lower sections. CU, UH, and UK, also held the same positions in the lower section in both charts, while TSU shifted from the upper to lower, with KU moving in the opposite manner. With the

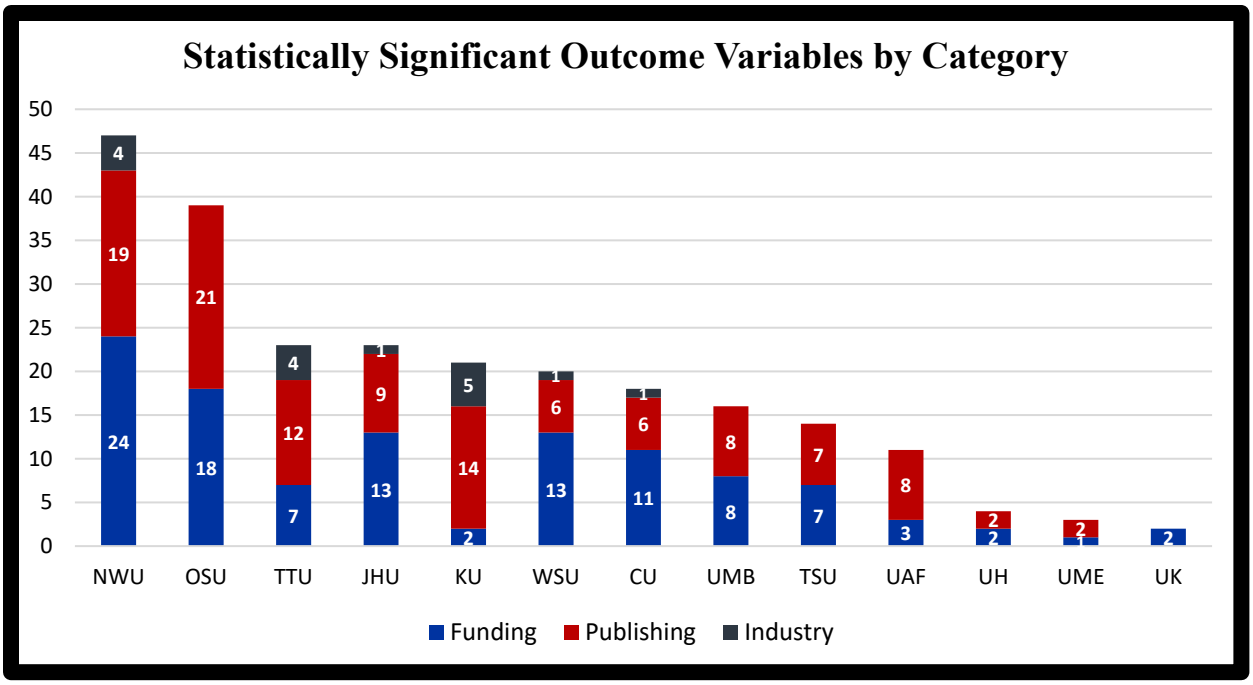

Figure 5.14: Statistically significant outcome variables by category

exception of TSU and KU, having eleven of the thirteen universities remain stable relative to the two charts could help to support the idea that institutional financial and personnel variables do indeed impact research outcomes, in particular funding. The outlier of KU can also be explained when examining the types of statistically significant correlations that were found.

Figure 5.14 breaks-down the correlations for each university into the three categories for financial, personnel and industry related variables. A closer look at KU shows that while they had one of the higher amounts of significant correlations, only two of them were related to funding. This would explain KU's compared positions in Figures 5.9 and 5.13, removing them as an outlier since their higher amount of correlations were not related to funding and would not conflict with the view that more institutional infrastructure support correlates to higher research outcomes.

Diving deeper into the significant correlations between infrastructure variables and research outcomes, Figure 5.15 exposes which infrastructure variables were found related to each

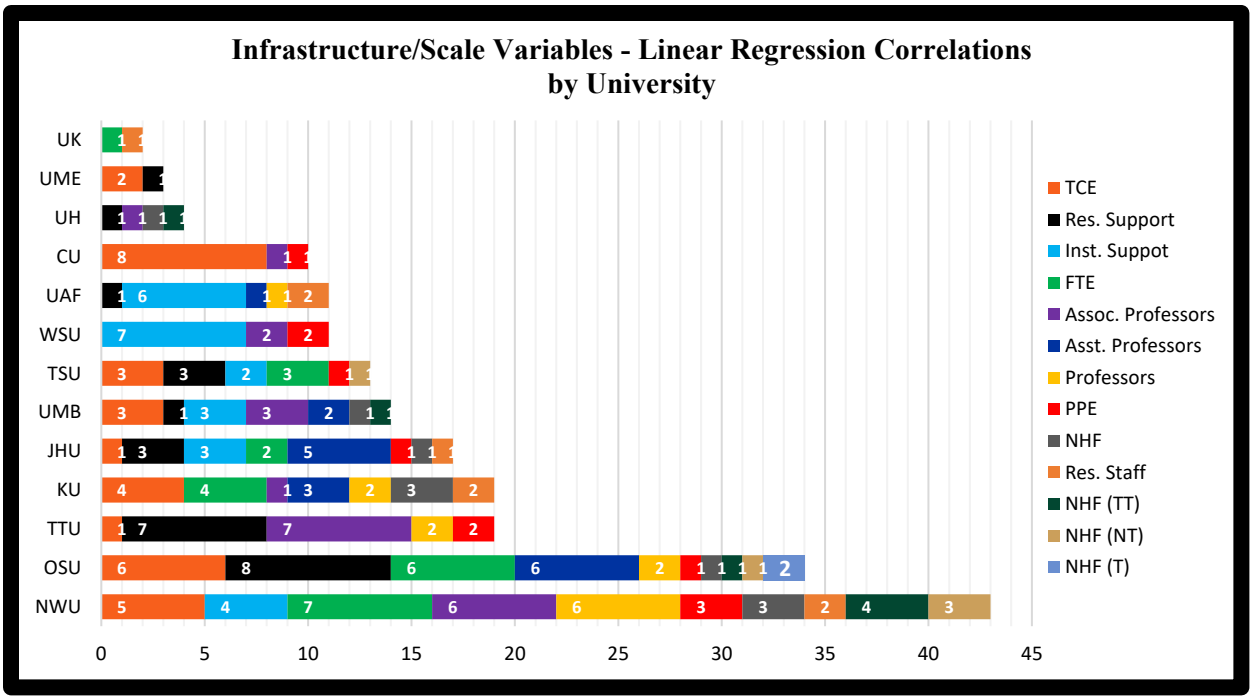

Figure 5.15: Statistically Significant Infrastructure Variables by University

university, and how many correlations to research outcomes each contributed. This provides insight into not only which universities had the most correlations, but which variables had the greatest influence. For example, NWU had the highest number of statistically significant correlations, 43 being directly linked to infrastructure variables, with seven related to FTE, six to Professors, six to Associate Professors, and five to Total Core Expenses. Taken together with Figure 5.14, showing an even mix of correlations to funding and publishing variables, which would indicate that NWU's senior faculty, overall staff, and core support services, were actively functioning in a way that significantly contributed toward achieving research outcomes.

The results also underline the diverse nature of the research enterprise by displaying the unique mix of influences operating within each university. While senior faculty may have played a key role in NWU's research productivity, the correlations promote the impact that more junior faculty have made at OSU and JHU. The analysis also reveals the multiple pathways for directing financial resources that can encourage and support achievement in research. The three

fiscal veins charted through the IPEDS defining terms for Institutional Support, Research Support, and Total Core Expenses (see Appendix I), expressed differing rates of correlation throughout the sample. While Research Support appeared to play a dominant role at OSU and TTU, it went unrepresented for the correlations identified for NWU. WSU's financial correlations were concentrated in Institutional Support alone, further pressing the importance of understanding the individual context of each location when attempting to utilize an analysis such as this for strategic planning.

However, if a pattern is being sought to better understand where the greatest influence of research productivity resides, one does seem to emerge from the results in Figure 5.15. Several of the universities who experienced the higher rates of research outcome success, had evenly distributed numbers of significant correlations among the primary financial and personnel variables. Both NWU and OSU had higher numbers with the same, or close to the same, amounts of correlations distributed across their financial support, FTE, and faculty variables, as did TTU, TSU, JHU, and UMass Boston. In contrast, the universities who had experienced struggles in their quest for research productivity, had either a very low amount of significant correlations, as in the case of UH, UME and UK, an unequal distribution, as seen with UAF, or both. This could imply a demonstration that the most effective strategy is one that leverages multiple variables in an even distribution based on the unique characteristics of the institution.

Analysis by Classification Groups

Exploring the results based on the three classification groups provides a level of control by separating the differences between the levels and scales of the universities in the sample. The number of significant correlations identified in each group are displayed in Figure 5.16, where the two VHRA groups were separated by only two correlations, with the private universities

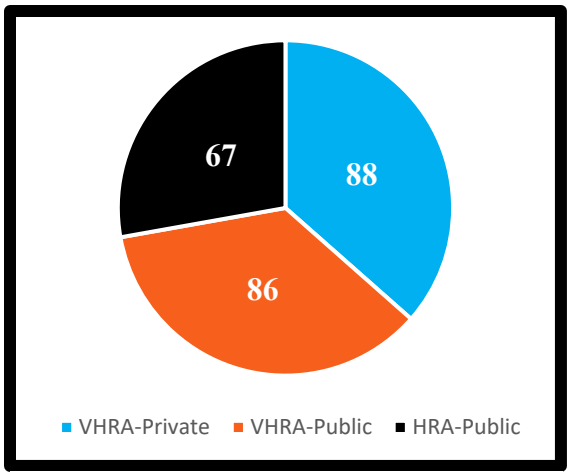

Figure 5.16: Number of significant correlations by classification group

holding the highest number. Despite having such a small gap between them, the smaller sample size of the private group, comprising three universities compared to five in each of the two public groups, multiplies the strength of their lead. The higher amount of significant correlations found in the VHRA-Private group, compared to the other two, may have been influenced by their larger size and longer history as research universities, as well as their being sheltered to the external influences of public oversight and fiscal control. Being public research universities, the other two groups are closely intertwined with the alternating currents of federal, state, and local policies, politics, and resources, presenting them with an uninoculated range of challenges not faced by the privately funded institutions. Following on this path, the lower amount of correlations identified for the HRA universities may be the result of their not having yet established long-standing and experienced research enterprises and lacking the years that it takes any institution to forge its own path and learn the most efficient means and methods for sustaining growth. As burgeoning research universities, they may have been more prone to changes in course while testing the various combinations of financial support and personnel management that the VHRA groups had already found effective and instituted.

Similar to Figure 5.15, Figure 5.17 visually provides the number of significant correlations related to infrastructure variables for each of the three classification groups. The visual representation of this data shows the variables with the largest influence, or impact, for each of the three groups. The VHRA-Private group correlated well with the institution's core

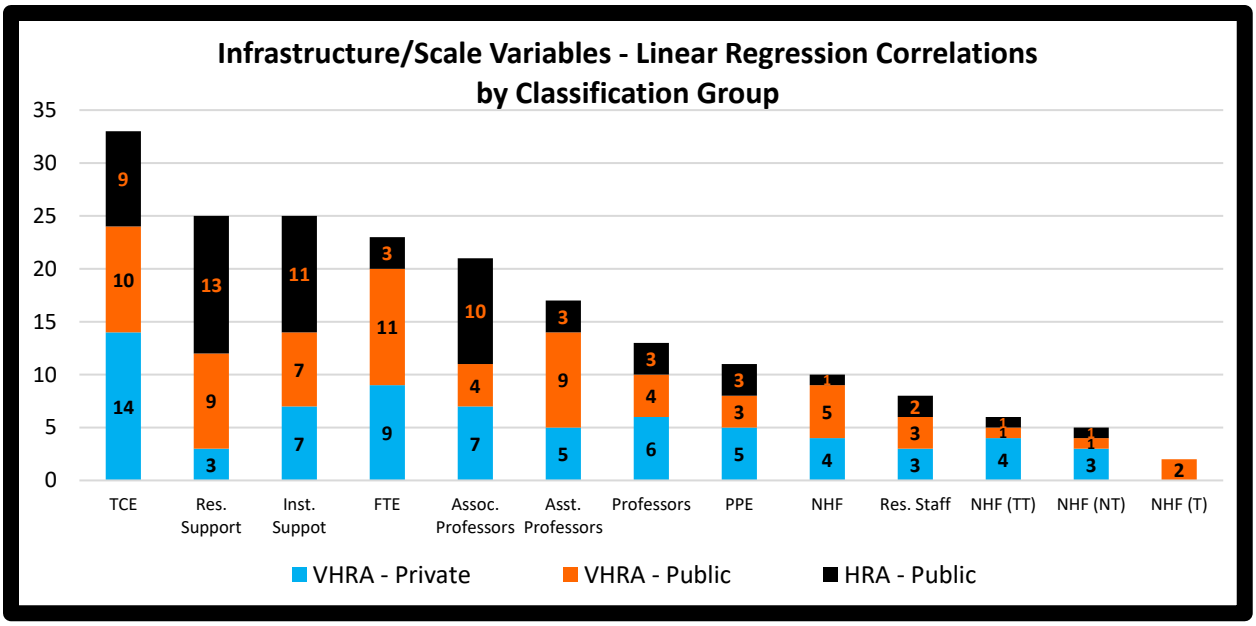

Figure 5.17: Number of Significant Infrastructure Variables by Classification Group

expenses, while the VHRA-Public group related closely with their FTE staff, and the HRA universities seem to rely on their research and institutional support.

In addition to examining the correlations found for each university by dividing them into their groups, the project also conducted a new round of analysis testing on each group as a whole independent unit, using the combined data from each university within the group. The initial Pearson Correlation tests identified thirteen correlations for the VHRA-Private group, six for the VHRA-Public group, and seven for the HRA-Public group. Further results of the linear regression analysis performed, pinpointed four significant correlations for the HRA group, linking research support and FTE to total R&D, professors to NIH funding, and TCE to publications. One correlation relating to professors and total R&D was found for the VHRA-Private group (see Appendix II for result data), while none of the correlations for the VHRA-Public group were found to be statistically significant.

Chapter 6: Discussion of Results and Conclusions

Several observations were made throughout the data analysis which provide insights into where correlations exist between institutional infrastructure and research productivity and for leadership to build effective strategies based on statistical data over budgetary reactions. The results painted both a broad portrait of the planning strategies and the outcomes that the sampled research universities implemented and experienced, while also illustrating the finer brush strokes that formed the details of the image.

6.1: Observations

The content analysis that was performed for each of the strategic plans in the sample, supported the literature regarding the importance of including financial plans for how the institution will reach its goals and objectives. The data analysis in Section 5.2, demonstrated that the universities who incorporated budget planning and included discussion or plans for increasing administrative and support personnel, had a greater range of success in the outcome areas of funding, publishing, and citation impact.

A surprising discovery of the content analysis was the apparent minimal effect that metrics included in strategic plans had on research productivity. Discussed was the possible explanation, that given the lack of any one component of the institutional enterprise over the internal and external factors that influence sponsor funding decisions, setting metrically defined funding goals may simply be too uncontrollable to have a correlated effect.

Using the Carnegie Classifications to act as a control for comparing the universities according to the groups as HRA and VHRA both public and private, exposed one of the largest highlighting factors that was prevalent throughout the various sections of analysis. Viewing the results through the classification groups underlined the power of institutional motivation, through

the high rates of funding and productivity achieved by some of the HRA universities. In particular, TSU exemplified the hypothesis that increased strategic planning for institutional investment, personnel support, and infrastructure resources, combined with a strong culture of research and motivation, leads to increased research outcomes.

Results from the statistical analysis, showed that higher numbers of significantly correlated infrastructure variables, evenly distributed among the primary financial and personnel variables, were associated with the universities that experienced higher levels of increased outcome rates. These results also supported the position for strategically planned institutional support structures and investment, by favoring the larger, well-established research universities of the VHRA groups, who have the legacy of tested and mature research enterprises.

An interesting observation emerging from the data analysis results, was the minimal significance in correlations related to the recruitment of new hire faculty. Focus on faculty recruitment is one of the dominant themes of research university strategic planning, and many universities throughout the research enterprise view recruitment as the most expedient method of increasing their research outcomes. However, this view was simply not supported by the data results of this project. There were many significant correlations to faculty at multiple levels, however the specific variables for new hire faculty, for which four levels covering faculty experience were used, were not well represented in the results. While there are of course many factors and influences that may affect this outcome, for this sample at least, the results would indicate that recruitment has less of an effect on increasing outcome rates than have been widely hoped for.

6.2: Limitations and Future Study

The main limitation of this project is the sample size since a much larger sample would be necessary to arrive at any definitive conclusions. The complex nature of the intertwining influences that impact each of the variables, along with the unique and diverse characteristics that separate each research university from one another, make attempts at statistical analysis in this area challenging. Indeed, this was witnessed in the literature in which previous studies experienced difficulties with designing statistical models that best fit the data.[48] Another limitation is related to the data obtained through the IPEDS survey, which, while quite comprehensive, is based on institutional self-reporting and therefore has the potential to be biased or inaccurate. However, without direct access to internal financial and personnel information to verify accuracy, the IPEDS data still provides a publicly available and detailed window into the overall operations of academic and research universities.

The focus of this project was on the institutional effect toward increasing research outcome measures, and therefore only analyzed correlations that were on the positive side of the scale, showing correlations related to increase. However, an equally negative correlation does not mean that one does not exist, but rather it indicates a correlation moving toward decline. Further study and analysis could be conducted to investigate any variables that may negatively influence research outcomes by actually contributing toward their downward trend. Such an analysis could be useful for a research university, or institution, looking to understand their failure as well as their success.

[48] Morphew, C. C., Fumasoli, T. & Stensaker, B. *Changing missions?*

6.3: Conclusions

The research enterprise is a uniquely complex, and at times quixotical, environment full of science non-fiction magic, discovery, knowledge, intrigue, politics, money, and imagination. Yet, through it all, the strategic passages and landmines that weave through and dot its landscape, can be exposed to reveal the most efficient and advantageous way forward. Understanding the tried and tested features of the strategic planning process, combined with a focused analysis of where potential correlations exist and where strengths can be reinforced, and weaknesses can be mitigated, can lead an active research culture toward improvement and advancement. Exploratory in its nature, this project can conclude that strategic planning and strategic thinking do have a correlating effect on the research performance of the institution. The results of the data analysis work to support the hypothesis that increased attention through strategic planning and institutional investment in the financial and personnel support infrastructure, does indeed have a significant impact on the level of research productivity, as experienced through expanded funding, publishing and citation impact.

The project further concludes that the value of strategic planning is advocated not by the defining of simple goals and metrics, but through its use as a tool for building a culture of research, grounded in reality, that encourages the collective motivation to advance toward the still attainable ideal.

Appendix I

IPEDS Survey Glossary Terms

https://surveys.nces.ed.gov/ipeds/VisGlossaryAll.aspx

Institutional Support	A functional expense category that includes expenses for the day-to-day operational support of the institution. Includes expenses for general administrative services, central executive-level activities concerned with management and long-range planning, legal and fiscal operations, space management, employee personnel and records, logistical services such as purchasing and printing, and public relations and development. Also includes information technology expenses related to institutional support activities. If an institution does not separately budget and expense information technology resources, the IT costs associated with student services and operation and maintenance of plant will also be applied to this function.
Research Support	A functional expense category that includes expenses for activities specifically organized to produce research outcomes and commissioned by an agency either external to the institution or separately budgeted by an organizational unit within the institution. The category includes institutes and research centers, and individual and project research. This function does not include non-research sponsored programs (e.g., training programs). Also included are information technology expenses related to research activities if the institution separately budgets and expenses information technology resources (otherwise these expenses are included in academic support.) Institutions include actual or allocated costs for operation and maintenance of plant, interest, and depreciation.
Research Staff	An occupational category used to classify persons whose specific assignments customarily are made for the purpose of conducting research. Regardless of title, academic rank, or tenure status, these employees formally spend the majority of their time conducting research.
Total Core Expenses	Total expenses for the essential education activities of the institution. Core expenses for public institutions reporting under GASB standards include expenses for instruction, research, public service, academic support, student services, institutional support, operation and maintenance of plant, depreciation, scholarships and fellowships, interest and other operating and nonoperating expenses. Core expenses for FASB (primarily private, not-for-profit and for-profit) institutions include expenses on instruction, research, public service, academic support, student services, institutional support, net grant aid to students, and other expenses. For both FASB and GASB institutions, core expenses exclude expenses for auxiliary enterprises (e.g., bookstores, dormitories), hospitals, and independent operations.

Appendix II

Statistical Analysis Results Data

Statistically Significant Correlations by University				
University	**Variable**	**Variable**	**R^2**	**P-value**
OSU	Research Support	Total R&D	0.7905	0.0178
		Federal R&D	0.852	0.0253
		NIH	0.8122	0.0142
		Total Citations	0.7285	0.0306
		Normalized Citations	0.8687	0.0068
		Publications	0.7852	0.0187
		Collaborative Publications	0.8217	0.0127
		Top 5% Publications	0.8874	0.0049
	Total Core Expenses (TCE)	Total R&D	0.9545	0.0008
		Total Citations	0.8497	0.0099
		Normalized Citations	0.8159	0.0136
		Publications	0.7225	0.0321
		Collaborative Publications	0.759	0.0238
		Top 5% Publications	0.7576	0.0241
	Plant, Property & Equipment (PPE)	Total R&D	0.8494	0.009
	Full Time Employees (FTE)	Total R&D	0.8443	0.0096
		NIH	0.7149	0.018
		Total Citations	0.9233	0.0023
		Publications	0.9787	0.0002
		Collaborative Publications	0.9769	0.0002
		Top 5% Publications	0.957	0.0007
	Professors	NIH	0.7919	0.0175
		Top 5% Publications	0.7564	0.0244
	Assistant Professors	Total R&D	0.8047	0.0154
		NIH	0.7973	0.0166
		Total Citations	0.888	0.0049
		Normalized Citations	0.9336	0.0017
		Publications	0.8869	0.005
		Collaborative Publications	0.8852	0.0051
	New Hire Faculty – Tenured	NIH	0.8361	0.0107
		Normalized Citations	0.7623	0.0231
	New Hire Faculty – Non-Tenure Track	NIH	0.8504	0.0088
	New Hire Faculty – Total	Top 5% Publications	0.7713	0.0213

	Total Citations	Total R&D	0.9387	0.0014
	Normalized Citations	Total R&D	0.881	0.0055
		NIH	0.7139	0.0342
	Publications	Total R&D	0.833	0.0111
	Top 5% Publications	Total R&D	0.7627	0.0231
		NIH	0.8598	0.0077
NWU	Institutional Support	Mean Citations	0.8859	0.0051
		Total Citations	0.7878	0.0182
		Top 5% Publications	0.7763	0.0204
		Industry Publications	0.802	0.0158
	Total Core Expenses (TCE)	Total R&D	0.8289	0.0117
		Federal R&D	0.8003	0.0161
		NIH	0.7825	0.0192
		Total Citations	0.944	0.0012
		Publications	0.9828	0.0001
	Plant, Property & Equipment (PPE)	Total R&D	0.8892	0.0048
		Federal R&D	0.8855	0.0051
		NIH	0.8841	0.0052
	Research Staff	Mean Citations	0.8203	0.0129
		Total Citations	0.7121	0.0347
	Full Time Employees (FTE)	Total R&D	0.8105	0.0144
		Federal R&D	0.6873	0.0413
		NIH	0.6917	0.0401
		Total Citations	0.8836	0.0053
		Collaborative Publications	0.8555	0.0082
		Top 5% Publications	0.9373	0.0015
		Industry Publications	0.9055	0.0035
	Professors	Total Citations	0.9245	0.0022
		Publications	0.9299	0.0019
		Collaborative Publications	0.9058	0.0034
		Top 5% Publications	0.8404	0.0101
		Industry Publications	0.8192	0.0131
		Patent Applications	0.776	0.0204
	Associate Professors	Total R&D	0.8583	0.0079
		NIH	0.6903	0.0405
		Total Citations	0.7914	0.0176
		Publications	0.7799	0.0197
		Collaborative Publications	0.8035	0.0156
		Top 5% Publications	0.8611	0.0076
	New Hire Faculty – Tenure Track	Total R&D	0.8519	0.0087
		Federal R&D	0.8581	0.0079
		NIH	0.903	0.0036

		Top 5% Publications	0.6782	0.0441
	New Hire Faculty – Non-Tenure Track	Total R&D	0.74	0.0279
		Federal R&D	0.8117	0.0142
		NIH	0.84	0.009
	New Hire Faculty - Total	Total R&D	0.9584	0.0007
		Federal R&D	0.8117	0.0142
		NIH	0.8656	0.0071
	Publications	Federal R&D	0.7735	0.021
		NIH	0.7328	0.0296
	Top 5% Publications	Federal R&D	0.8178	0.0133
		NIH	0.7815	0.0194
JHU	Institutional Support	Total R&D	0.8401	0.0101
		Total Citations	0.9137	0.0029
		Total 1% Publications	0.9073	0.0033
	Research Support	Total R&D	0.8343	0.0109
		Total Citations	0.9137	0.0029
		Total 1% Publications	0.9161	0.0027
	Total Core Expenses (TCE)	Total R&D	0.8541	0.0084
	Plant, Property & Equipment (PPE)	Total R&D	0.8761	0.006
	Research Staff	Patent Applications	0.6627	0.018
	Full Time Employees (FTE)	Total R&D	0.6887	0.0409
		Total Citations	0.83	0.0115
	Assistant Professors	Total R&D	0.823	0.0125
		Total Citations	0.8395	0.0102
		Normalized Citations	0.8333	0.0111
		Publications	0.8749	0.0061
		Collaborative Publications	0.8838	0.0053
	New Hire Faculty - Total	Total R&D	0.8358	0.0107
	Industry Publications	Total R&D	0.8382	0.0104
	Total Citations	Total R&D	0.8962	0.0042
	Normalized Citations	Total R&D	0.8951	0.0043
	Publications	Total R&D	0.8947	0.0043
	Collaborative Publications	Total R&D	0.8877	0.0049
	Top 1% Publications	Total R&D	0.8671	0.0069
KU	Total Core Expenses	Normalized Citations	0.7325	0.0297
		Publications	0.9036	0.0036
		Collaborative Publications	0.949	0.00009
		Industry Publications	0.9075	0.0033
	Research Staff	Publications	0.8215	0.0127
		Collaborative Publications	0.8018	0.0158

	Full Time Employees (FTE)	Normalized Citations	0.7653	0.0225
		Publications	0.9455	0.0011
		Collaborative Publications	0.9833	0.0001
		Industry Publications	0.9141	0.0029
	Professors	Collaborative Publications	0.7863	0.0185
		Industry Publications	0.8244	0.0123
	Associate Professors	Mean Citations	0.6926	0.0399
	Assistant Professors	Publications	0.8157	0.0136
		Collaborative Publications	0.9094	0.0032
		Industry Publications	0.8109	0.0144
	New Hire Faculty – Total	Publications	0.7247	0.0315
		Collaborative Publications	0.8074	0.0149
		Industry Publications	0.9316	0.0018
	Top 1% Publications	Total R&D	0.9247	0.0022
	Top 5% Publications	Total R&D	0.8911	0.0046
TTU	Research Support	Total R&D	0.7968	0.0167
		Patent Applications	0.8809	0.0055
		Mean Citations	0.8899	0.0047
		Publications	0.9642	0.0005
		Collaborative Publications	0.9597	0.0006
		Top 1% Publications	0.9163	0.0027
		Top 5% Publications	0.973	0.0003
	Total Core Expenses	Patent Applications	0.7213	0.0324
	Plant, Property & Equipment (PPE)	Total R&D	0.6963	0.0388
		Patent Applications	0.8823	0.0054
	Professors	Total R&D	0.7365	0.0287
		Publications	0.7945	0.017
	Associate Professors	Patent Applications	0.8433	0.0097
		Mean Citations	0.8997	0.004
		Total Citations	0.8466	0.0093
		Publications	0.7557	0.0245
		Collaborative Publications	0.7339	0.0294
		Top 1% Publications	0.6988	0.0382
		Top 5% Publications	0.8123	0.0141
	Total Citations	Total R&D	0.6906	0.0404
	Publications	Total R&D	0.7124	0.0346
	Collaborative Publications	Total R&D	0.7228	0.032
	Top 5% Publications	Total R&D	0.7006	0.0377
WSU	Institutional Support	Total R&D	0.7877	0.0183
		Mean Citations	0.753	0.0251

		Total Citations	0.8487	0.0091
		Normalized Citations	0.7372	0.0286
		Publications	0.888	0.0049
		Collaborative Publications	0.8971	0.0041
		Industry Publications	0.8634	0.0073
	Plant, Property & Equipment (PPE)	Total R&D	0.9667	0.0004
		NIH	0.8227	0.0126
	Associate Professors	NIH	0.7411	0.0277
		Top 1% Publications	0.8139	0.0139
	Mean Citations	Total R&D	0.8446	0.0096
		NIH	0.8857	0.0051
	Total Citations	Total R&D	0.9309	0.0018
		NIH	0.8637	0.0073
	Normalized Citations	Total R&D	0.8133	0.013
		NIH	0.9063	0.0034
	Publications	Total R&D	0.9702	0.0003
	Collaborative Publications	Total R&D	0.9502	0.0009
	Industry Publications	Total R&D	0.7807	0.0195
CU	Total Core Expenses	Total R&D	0.8757	0.0061
		Total Citations	0.9015	0.0038
		Normalized Citations	0.8811	0.0055
		Publications	0.9278	0.002
		Collaborative Publications	0.8952	0.0043
		Top 1% Publications	0.8334	0.011
		Top 5% Publications	0.7623	0.0231
		Industry Publications	0.7261	0.0312
	Plant, Property & Equipment (PPE)	Total R&D	0.9252	0.0022
	Associate Professors	Federal R&D	0.9076	0.0033
	Mean Citations	Total R&D	0.871	0.0065
	Total Citations	Total R&D	0.9307	0.0018
	Normalized Citations	Total R&D	0.8675	0.0069
	Publications	Total R&D	0.9656	0.0004
	Collaborative Publications	Total R&D	0.9707	0.0003
	Top 1% Publications	Total R&D	0.8233	0.0125
	Top 5% Publications	Total R&D	0.7064	0.0361
	Industry Publications	Total R&D	0.8981	0.004
UMass Boston (UMB)	Institutional Support	Total R&D	0.7463	0.0265
		Publications	0.9034	0.0036
		Total Citations	0.9378	0.0015
	Research Support	Total Citations	0.7731	0.021
		Total R&D	0.9177	0.0026

	Total Core Expenses (TCE)	Publications	0.9556	0.0007
		Total Citations	0.9809	0.0001
	Associate Professors	Total R&D	0.8223	0.0126
		Publications	0.9602	0.0006
		Total Citations	0.9788	0.0002
	Assistant Professors	Total R&D	0.7538	0.0249
		Publications	0.7946	0.0171
	New Hire Faculty – Tenure Track	Total R&D	0.7694	0.0217
	New Hire Faculty – Total	Total R&D	0.7989	0.0163
	Publications	Total R&D	0.9235	0.0023
	Total Citations	Total R&D	0.8351	0.0108
TSU	Institutional Support	Publications	0.836	0.0297
		Total R&D	0.8286	0.0318
	Research Support	Total R&D	0.9626	0.0031
		Publications	0.8515	0.0255
		Total Citations	0.8458	0.027
	Total Core Expenses (TCE)	Total R&D	0.9633	0.003
		Publications	0.9955	0.0001
		Total Citations	0.9862	0.0007
	Plant, Property & Equipment (PPE)	Total R&D	0.9719	0.002
	Full Time Employees (FTE)	Total R&D	0.9055	0.0127
		Publications	0.9142	0.0109
		Total Citations	0.9599	0.0034
	New Hire Faculty – Non-Tenure Track	Federal R&D	0.957	0.022
	Total Citations	Total R&D	0.9542	0.0042
UAF	Institutional Support	Total Citations	0.943	0.0012
		Normalized Citations	0.9585	0.0007
		Publications	0.7331	0.031
		Collaborative Publications	0.8868	0.005
		Top 1% Publications	0.8142	0.0138
		Top 5% Publications	0.7663	0.0223
	Research Support	Total R&D	0.6781	0.044
	Research Staff	Publications	0.8217	0.0127
		Top 5% Publications	0.8342	0.0109
	Professors	NIH	0.7174	0.0333
	Assistant Professors	Total R&D	0.83	0.0115
UH	Research Support	Top 5% Publications	0.9292	0.0082
	Associate Professors	Publications	0.8587	0.0236
	New Hire Faculty – Tenure Track	Federal R&D	0.9754	0.0016
	New Hire Faculty – Total	Federal R&D	0.9179	0.0102

UME	Research Support	Total R&D	0.6647	0.048
	Total Core Expenses (TCE)	Publications	0.9571	0.0007
		Total Citations	0.9487	0.001
UK	Research Staff	Federal R&D	0.8004	0.0161
	Full Time Employees (FTE)	Total R&D	0.7967	0.0167

Statistically Significant Correlations by Classification Group

Group	Variable	Variable	R^2	P-value
HRA – Public	Research Support	Total R&D	0.8836	0.0175
	Full Time Employees (FTE)	Total R&D	0.9421	0.006
	Total Core Expenses (TCE)	Publications	0.8415	0.0282
	Professors	NIH	0.8446	0.0273
VHRA – Private	Total Core Expenses (TCE)	Total R&D	0.9998	0.0083

Appendix III

Strategic Plans

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Biography

John L. Monetti was born in 1980 in Los Angeles County, California. After working for several years as a skilled structural welder, he completed his undergraduate studies in History, obtaining a Bachelor of Arts degree from California State University, Long Beach in 2009. During that time, his studies focused on nineteenth-century American history, with an emphasis on literature and politics.

In 2010, he joined Cedars-Sinai Medical Center where he began working with basic and clinical scientists in research administration. Since joining CSMC, John has had an active role in research administration at both the laboratory and central office levels and currently serves as a Grant and Contract Officer and institutional official covering a large and diverse portfolio of research areas. Looking to further both his academic and professional studies, he began his journey at Johns Hopkins University in 2017 in pursuit of his Master of Science degree in the field of Research Administration. As his journey continues beyond Johns Hopkins, he looks forward to expanding his collaborations and contributing to the advancement of academic and scientific research.